PROCEEDINGS

OF THE

THIRTY-FIFTH

INDIAN SCIENCE CONGRESS

PATNA, 1948.

PART I

OFFICIAL MATTERS

CONTENTS

THIRTY-FIFTH
INDIAN SCIENCE CONGRESS
PATNA, 1948

I. OFFICERS OF THE THIRTY-FIFTH CONGRESS

PATRON

His Excellency Sri Jairamdas Daulatram, Governor of Bihar.

PRESIDENT

Col. Sir Ram Nath Chopra, Kt. C.I.E., M.A., M.D., Sc.D., F.R.C.P., M.P.S. (Hon.), F.R.A.S.B., F.N.I.

GENERAL SECRETARIES

Prof. M. Qureshi, M.Sc., Ph.D., F.N.I.,

Prof. P. C. Mahalanobis, F.R.S. (on leave)

Dr B. Mukerji, D.Sc., M.D., F.N.I. (Acting in place of Prof. Mahalanobis).

TREASURER

Prof. P. Ray, M.A., F.N.I.

LOCAL SECRETARIES

Dr. B. Narayana, M.Sc., M.B., Ph.D., F.R.S.E., F.N.I.

Dr. P. B. Ganguly, D. Sc., F.N.I.

SECTIONAL PRESIDENTS

Mathematics--Dr. R. Vaidyanathaswamy, M.A., Ph.D., D.Sc., *Reader in Mathematics, University of Madras, Chepauk, Madras.*

Statistics—Mr. S. N. Roy, M.Sc., F.N.I., *Department of Statistics, Calcutta University, Statistical Laboratory, Presidency College Calcutta.*

Physics—Dr. L. A. Ramdas, M.B.E., M.A., Ph.D., F.A.Sc., F.N.A.Sc., F.N.I., *Director, Agricultural Meteorology, Meteorological Office, Poona 5*

Chemistry—Prof. B. Sanjiva Rao, M.A., Ph.D., D.Sc., (Lond.), F.N.I., *Principal, Central College, Bangalore.*

Geology and Geography—Dr. P. K. Ghosh, D.Sc., Ph.D., F.N.I., *Deputy Director, Geological Survey of India, 27, Chowringhee, Calcutta.*

Botany—Dr. K. A. Chaudhury, M.B.E., D.Sc., F.N.I., *Wood Technologist, Forest Research Institute, New-Forest, Dehra-Dun (U.P.).*

Zoology and Entomology—Prof. A. B. Misra, D.Sc., D.Phil. (Oxon.) F.Z.S., F.R.E.S., *University Professor of Zoology, Dean of the Faculty of Science, Actg. Principal, College of Agriculture, Benares Hindu University, Benares.*

Anthropology and Archaeology—Mr. A. Chatterjee, M.B.B.S., *Lecturer in Anthropology, University College of Science, 35, Ballygunge Circular Road, Calcutta.*

Medical and Veterinary Sciences—Dr. G. D. Bhalerao, D.Sc., Ph.D., *Director, Indian Veterinary Research Institute, Izatnagar, Bareilly, U.P.*

Agricultural Sciences—Rai Bahadur Kali Das Sawhney, M.Sc., *Director of Agriculture, Hyderabad, Deccan.*

Physiology—Dr. Bashir Ahmad, M. Sc., Ph. D. (Lond.), *National Chemical Laboratory Council of Scientific and Industrial Research, 1, Ganeshkhind Road, Poona 5.*

Psychology and Educational Science—Dr. Zakir Husain, M.A., Ph.D., *Principal, Jamia Millia Islamia, Jamianagar, Delhi.*

Engineering and Metallurgy—Mr. N. Sen, M.Met., B.Sc., F.I.C., *Chief Chemist, Tata Iron and Steel Co., Ltd., Jamshedpur.*

SECTIONAL RECORDERS

Mathematics—Prof. B. B. Sen, *Professor of Mathematics, Bengal Engineering College, Shibpur, Howrah.*

Statistics—Dr. C. Chandra Sekar, Ph.D., *Professor of Vital Statistics, All India Institute Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.*

Physics—Dr. A. K. Dutta, D.Sc., *Reader in Physics, University of Dacca, Dacca.*

Chemistry—Dr. U. P. Basu, D.Sc., F.N.I., *Chief Chemist, Bengal Immunity Co. Ltd., Calcutta.*

Geology and Geography—Dr. Mohammad Younus, M.A., LL.B., Ph D., *Lecturer in Geography, Muslim University, Aligarh.*

Botany—*S. Ramanujam,* M. A., Ph.D., *Director, Central Potato Research Institute, New Delhi.*

Zoology and Entomology—Dr. D. V. Bal, M.Sc., Ph.D., F.A.Sc., *Professor of Zoology, Royal Institute of Science, Mayo Road, Bombay.*

Anthropology and Archaeology—Dr. P. C. Biswas, Ph.D., *Reader in Anthropology, University of Delhi, Delhi.*

Medical and Veterinary Sciences—Dr. Susil Kumar Basu, M Sc., M B., D.T.M., D.P.H., Ph. D., *Superintending Anthropologist, Anthropological Survey of India, 64, Cantonment Road, Benares Cant.*

Agricultural Sciences—Dr. R. S. Vasudeva, Ph.D., D.I.C. (Lond.), *Plant Pathologist, Indian Agricultural Research Institute, New Delhi.*

Physiology—Dr. (Miss) Kamala Bhagwat, M. Sc., (Lond.), Ph.D. (Cantab.), *Assistant Director, Nutrition Laboratory, Coonoor, S. I.*

Psychology and Education Sciences—Prof. T. K. N. Menon, B.A., T.D., M. Ed. *Principal, Secondary Teachers Training College, Baroda.*

Engineering and Metallurgy—Prof. M. Sen Gupta, B.Sc., (Cal.), B.Sc. Eng. (Glass), M.I.E.E. (Lond.), M.I.E. (Ind.), C.P.E. (Glass), A.M.I.Mech.E, (Lond.), F.I.P.S., *University Professor and Head of the Dept. of Electrical Engineering and Principal, Engineering College, Benares Hindu University, Benares.*

SECTIONAL CORRESPONDENTS

Mathematics—Mr. U. R. Burman, M.Sc., *Lecturer in Applied Mathematics, University College of Science, 92, Upper Circular Road, Calcutta.*

Statistics—Mr. Purnendu Kumar Bose, M. Sc., *Lecturer in Statistics, Calcutta University, Calcutta.*

Physics—Dr. H. Rakshit, D.Sc., F.Inst.P., *Lecturer in Applied Physics, University College of Science, 92, Upper Circular Road, Calcutta.*

Chemistry—Dr. D. Chakravarty, D.Sc., *Lecturer in Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.*

Geology and Geography—Mr. Subodh Chandra Bose, M.A., *Lecturer in Geography, Vidyasagar College, Calcutta.*

Botany—Mr. A. K. Ghosh, M.Sc., *Lecturer in Botany, University College of Science, 35, Ballygunge Circular Road, Calcutta.*

Zoology and Entomology- Mr. J. N. Rudra, M.Sc., *Lecturer in Zoology, University College of Science, 35, Ballygunge Circular Road, Calcutta.*

Anthropology and Archaeology Mr. S. S. Sarkar, M.A., *Research Fellow in Anthropology, Bose Research Institute, 93, Upper Circular Road, Calcutta.*

Medical and Veterinary Sciences -Mr. Arun Ganguli, Z.D.S. (Vienna), *26, Chowringhee Road, Calcutta.*

Agricultural Sciences—Dr. Hiran C. Chaudhuri, M A., Ph.D., (Lond.), Ph.D. (Edin.), *Special Officer, Potatoes, Bengal, Writers' Building, Bloc No, 1, (Top Floor), Calcutta.*

Physiology Mr. N. N. Das, M.Sc., *Lecturer in Physiology, University College of Science, 92, Upper Circular Road, Calcutta.*

Psychology and Educational Science—Mr. D. Ganguly, M. Sc., *Department of Psychology, University College of Science, 92, Upper Circular Road, Calcutta.*

Engineering and Metallurgy—Mr. J. Ganguly, B.E., M.I.E. (Ind.), 7-1A, *Mohan Lall Street, Calcutta.*

LOCAL SECTIONAL SECRETARIES

Mathematics—Prof. P. N. Das Gupta, *Professor of Mathematics, Science College, Patna.*

Statistics—Mr. V. R. Chariar, *Assistant Professor of Mathematics, Science College, Patna.*

Physics—Prof. S. P. Prasad, *Professor of Physics, Science College, Patna.*

Chemistry—Dr. P. C. Sinha, *Professor of Chemistry, Science College, Patna.*

Geology and Geography—Rao Bahadur Dr. L. A. N. Iyer, *Tata Professor of Geology, Patna University, Patna.*

Botany—Mr. R. C. Lacy, *Professor of Botany, Science College, Patna.*

Zoology and Entomology— Mr. M. A. Majeed, *Professor of Zoology, Science College, Patna.*

Anthropology and Archaelogy—Mr. S. A. Shere, *Curator, Patna Museum, Patna.*

Medical and Veterinary Sciences—Prof. B. N. Prasad, *Professor of Pharmacology P. W. Medical College, Patna.*

Agricultural Science—Mr. B. N. Sinha, *Deputy Director of Agriculture, Bihar,* c/o *The Registrar, Patna University.*

Physiology—Dr. M. Shah, *Department of Physiology, P.W. Medical College, Patna.*

Psychology and Educational Science—Prof. H. P. Maiti, *Head of the Institute of Applied Psychology, Patna University, Patna.*

Engineering and metallurgy—Mr. Bhagwat Prasad, *Principal, Engineering College, P.O. Mlahendra, Patna.*

2. OFFICERS OF THE ASSOCIATION FOR 1947-48

EXECUTIVE COMMITTEE

1.	Jawaharlal Nehru	*President.*
2.	Col. Sir R. N. Chopra, Kt., C.I.E., M.A., M.D., Sc.D., F.R.C.P., F.N.I., F.R.A.S.B.	*President-Elect.*
3.	Prof. M. Qureshi M. Sc., Ph.D., F.N.I. ..	*General Secretaries.*
4.	Prof. P. C. Mahalnobis, F. R.S.	
12.	Dr. B. Mukerji, D.Sc., M.D., F.N.I.	*Acting General Secretary.*
5.	Prof. P. Ray, M.A., F.N.I.	*Treasurer.*
6.	Prof. K. Banerjee, D.Sc., F.N.I.	*Elected by General Committee.*
7.	Dr. U. P. Basu, D.Sc., F.N.I.	
8.	Prof. S. N. Bose, M.Sc., F.N.I.	
9.	Dr. S. L. Hora, D.Sc., F.N.I., F.Z.S., F.R.A.S.B.	
10.	Prof. M. Afzal Husain, M. A., M.Sc., F.N.I. ..	
11.	Prof. S. K. Mitra, M.B.E., D.Sc., F.N.I. ..	
12.	Dr. B. Mukerji, D. Sc., M. D., F.N.I.	
13.	Prof. Mata Prasad, D. Sc., F.N.I.	
14.	Prof. M. Sen Gupta, B.Sc., C.P.E. A.M.I.E.E. ..	
15.	Prof. A. C. Ukil, M.B., M.S.P.E., F.S.M.F.B., F.N.I.	
16.	Dr. B. Narayana, M.Sc., M.B., Ph.D., F.R.S.E. ..	*Local Secretaries (Co-opted)*
17.	Dr. P. B. Ganguly, D.Sc., F.N.I.	

COUNCIL

(a) Members of the Executive Committee

(b) Past Presidents who are either Ordinary or Honorary Members

18. Sir M. Visvesvaraya, Kt. C.I.E., M. Inst.C.E., D.Sc.
19. Prof. J. L. Simonsen, D.Sc., F.I.C., F.R.S.
20. Sir Chandrasekhara Venkata Raman, Kt., Nobel Laureate.
21. Sir Lewis Leigh Fermor, Kt., O.B.E., D.Sc., F.G.S., A.R.S.M., M.Inst.M.M.. F.R.S., F.R.A.S.B., F.N.I.
22. Prof. M. N. Saha, D.Sc., F.R.S., F.R.A.S.B., F.N.I.
23. Dr. J. H. Hutton, C.I.E., M.A., D.Sc., F.R.A.S.B., F.N.I.
25. Sir T. S. Venkataraman, Kt., C.I.E., D.Sc.
25. Prof. B. Sahni, Sc.D., D.Sc., F.R.S.
26. Sir Ardeshir Dalal, Kt., I.C.S. (Retd.)
27. Sir Jnan Chandra Ghosh, Kt., D.Sc., F.N.I.
28. Mr. D. N. Wadia, M.A., B.Sc., F.G.S., F.R.A.S.B., F.N.I.
8. Prof. S. N. Bose, M.Sc., F.N.I.
29. Sir S. S. Bhatnagar, O.B.E., D.Sc., F.R.S., F.Inst.P., F.N.I., F.S.C.I. (Hon.)
10. Prof. M. Afzal Husain, M. A., M.Sc., F.N.I.

(c) Past General Secretaries who are either Ordinary or Honorary Members

19. Prof. J. L. Simonsen, D.Sc., F.I.C., F.R.S.

29. Sir Chandrasekhara Venkata Raman, Kt., Nobel Laureate.
30. Prof. S. P. Agharkar, M.A., Ph.D., F.L.S., F.N.I.
31. Dr. W. D. West, M.A., ScD., F.N.I.
32. Prof. J. N. Mukherjee, C.B.E., D.Sc., F.R.A.S.B., F.N.I.
33. Prof. P. Parija, O.B.E., M.A., I.E.S., F.N.I.
11. Prof. S. K. Mitra, M.B.E., D.Sc., F.N.I.
34. Prof. P. C. Mitter, Ph. D., F.N.I.
12. Dr. B. Mukerji, D. Sc., M.D., F.N.I.

(d) Past Treasurers who are either Ordinary or Honorary Members.

19. Prof. J. L. Simonsen, D. Sc., F.I.C., F.R.S.
20. Sir Chandrasekhara Venkata Raman, Kt., Nobel Laureate.
35. Dr. Baini Prashad, O.B.E., D.Sc., F.L.S., F.Z.S., F.R.S.E., F.N.I.
9. Rai Bahadur Dr. S. L. Hora, D.Sc., F.L.S., F.Z.S., F.R.A.S.B., F.N.I.
32. Prof. J. N. Mukherjee, C.B.E., D.Sc., F.R|A.S.B., F.N.I.

(e) Sectional Presidents for the Session (see the following list)

(f) Elected by General Committee.

49. Prof. S. P. Chakravarty, M.Sc., (Eng.), D.I.C., M.I.E.E.
50. Dr. B. C. Kundu, Ph.D., F.N.I.
51. Dr. M. A. Moghe, M.A., M.Sc., Ph.D.
52. Dr. K. L. Moudgil, M.A. (Cantab.), D.Sc., F.I.C.
16. Dr. B. Narayana, M.Sc., M.B., Ph.D., F.R.S.E.
53. Dr. B. N. Prasad, D.Sc., (Paris), Ph.D. (L. Pool), F.N.I.
54. Dr. B. B. Sarkar, D.Sc., F.R.S.E.

3. SECTIONAL COMMITTEES, 1947-48.

1. Mathematics—

Dr. R. Vaidyanathaswamy	..	*Convener.*
Prof. B. B. Sen ..	..	*Recorder.*
Mr. U. R. Burman ..	..	*Sectional Correspondent.*
Prof. P. N. Das Gupta	..	*Local Sectional Secretary.*
Mr. S. M. Kerawalla	..	*Elected Members.*
Dr. R. S. Verma ..	..	
Prof. N. R. Sen ..	..	*Past Presidents who are either Ordinary or Honorary Members*
Prof. A. C. Banerji ..	..	
*Prof. M. R. Siddiqi ..	..	
Mr. B. M. Sen ..	..	
*Dr. B. N. Prasad ..	..	
Dr. Ram Behari ..	..	
Dr. D. D. Kosambi ..	..	
Mr. S. Gupta ..	..	*Past Recorders who are either Ordinary or Honorary Members*
Dr. S. Ghosh ..	..	
Dr. N. G. Shabde ..	..	

2 Statistics—

*Mr. S. N. Roy ..	..	*Convener.*
Dr. C. Chandra Sekar	..	*Recorder.*
Mr. P. K. Bose ..	..	*Sectional Correspondent.*
Mr. V. R. Chariar ..	..	*Local Sectional Secretary.*

Dr. M. Ziaud-Din ..	..	*Elected Members.*
Mrs. Chameli Bose ..	..	
Prof. P. C. Mahalanobis	..	*Past President of the Mathematics and Statistics Section.*
Prof. K. B. Madhava	..	*Past Presidents of Statistics Section.*
Mr. R. C. Bose ..	..	
Dr. U. S. Nair ..	..	*Past Recorder of the Statistics Section.*

3. Physics

Dr. L. A. Ramdas ..		*Convener.*
Dr. A. K. Dutta ..	..	*Recorder.*
Dr. H. C. Rakshit ..	..	*Sectional Correspondent.*
Mr. S. P. Prasad ..	..	*Local Sectional Secretary.*
Dr. S. S. Dharmatti .	..	*Elected Members.*
Dr. N. K. Saha ..	..	
Sir C. V. Raman ..	..	*Past Presidents who are either Ordinary or Honorary Members.*
Mr. T. P. Bhaskara Shastri	..	
Dr. S. K. Banerji ..	..	
Prof. M. N. Saha ..	..	
Dr. D. M. Bose ..	..	
Prof. S. N. Bose ..	..	
Prof. B. Venkatesachar	..	
Prof. S. K. Mitra ..	..	
Dr. A. L. Narayan ..	..	
*Dr. S. Datta ..	..	
Diwan Bahadur K. R. Ramanathan		
Sir K. S. Krishnan ..	..	
Prof. H. J. Bhabha ..	..	
*Prof. D. S. Kothari ..	..	
*Dr. R. C. Majumdar	..	
Prof. S. Bhagavantam	..	
Prof. K. Banerjee ..	..	
Prof. G. R. Paranjpe	..	*Past Recorders who are either Ordinary or Honorary Members.*
Prof. J. Parameswaran	..	
Dr. R. K. Asundi ..	..	
Dr. D. V. Gogate ..	..	
Dr. N. R. Tawde ..	..	

4. Chemistry—

Prof. B. Sanjiva Rao	..	*Convener.*
Dr. U. P. Basu ..	..	*Recorder.*
Dr. D. Chakravarty ..	..	*Sectional Correspondent.*
Dr. P. Sinha ..	..	*Local Sectional Secretary.*
Dr. R. P. Mitra ..	..	*Elected Members.*
Dr. C. R. Barat ..	..	

Prof. J. L. Simonsen	..	*Past Presidents who are either Ordinary or Honorary Members.*
Dr. G. J. Fowler ..	..	
Prof. B. K. Singh ..	..	
Sir J. C. Ghosh ..	..	
Prof. B. B. Dey ..	..	
Sir S. S. Bhatnagar ..	..	
Prof. J. N. Mukherjee	..	
Prof. P. C. Mitter ..	..	
Dr. K. G. Naik ..	..	
Prof. P. Ray ..	..	
*Prof. P. Neogi ..	..	
*Prof. P. C. Guha ..	..	
*Dr. J. N. Ray ..	..	
Dr. P. B. Sarkar ..	..	
Dr. S. Krishna ..	..	
*Prof. Mata Prasad ..	..	
*Prof. M. Qureshi ..	..	
*Prof. S. S. Joshi ..	..	
*Prof. R. C. Ray ..	..	
*Prof. K. Venkataraman	..	
Dr. B. C. Guha ..	..	
*Dr. P. K. Bose ..	..	
Prof. D. D. Karve ..	..	*Past Recorders who are either Ordinary o Honorary Members.*
Mr. S. N. Mukherjee	..	
Dr. S. Siddiqui ..	..	
Prof. J. K. Chowdhury	..	

Geology and Geography—

Dr. P. K. Ghosh ..	..	*Convener.*
Dr. Mohammad Younus	..	*Recorder.*
Mr. Subodh Ch. Bose	..	*Sectional Correspondent.*
Dr. L. A. N. Iyer ..	..	*Local Sectional Secretary*
Dr. R. C. Misra ..	..	*Elected Members.*
Dr. A. K. De ..	..	
Mr. E. S. Pinfold ..	..	
Sir L. L. Fermor ..	..	*Past Presidents who are either Ordinary or Honorary Members.*
Prof B. Sahni ..	..	
Mr. D. N. Wadia ..	..	
Mr. P. Evans ..	..	
*Dr. M. S. Krishnan ..	..	
Dr. B. Rama Rao ..	..	
Dr. W. D. West ..	..	
*Prof. L. Rama Rao ..	..	
Dr. M. R. Sahni ..	..	
Dr. Rajnath ..	..	
*Dr. Shibaprasad Chatterjee	..	
Dr. S. M. Tahir Rizvi	..	
*Mr. George Kuriyan	..	
*Dr. A. S. Kalapesi ..	..	
*Mr. N. N. Chatterjee	..	
Dr. H. Crookshank ..	..	
*Dr. C. S. Pichamuthu	..	

Dr. C. Mahadevan	..	*Past Recorder who are either Ordinary or Honorary Members.*
Mr. V. P. Sondhi	..	
Prof. Maneck B. Pithawalla	..	
Mr. A. K. Banerjee	..	
Prof. Nafis Ahmed	..	
Dr. B. N. Mukerji	..	
Mr. L. S. Krishna Murthy	..	
Miss. L. A. Baker	..	
Mr. T. N. Muthuswami	..	

6. **Botany**—

Dr. K. A. Chaudhury	..	*Convener.*
Dr. S. Ramanujam	..	*Recorder.*
Mr. A. K. Ghosh	..	*Sectional Correspondent.*
Mr. R. C. Lacy	..	*Local Sectional Secretary*
Dr. M. B. Sadasivan	..	*Elected Members.*
Dr. P. N. Mehra	..	
Prof. B. Sahni	..	*Past Presidents who are either Ordinary or Honorary Members.*
Prof. S. P. Agharkar	..	
Prof. M. O. P. Iyengar	..	
Prof. K. C. Mehta	..	
Prof. P. Parija	..	
Prof. R. H. Dastur	..	
*Dr. S. R. Bose	..	
*Dr. Krishnadas Bagchee	..	
*Prof. Y. Bharadwaja	..	
Dr. Shri Ranjan	..	
Dr. N. L. Bor	..	
Dr. K. Biswas	..	
Dr. T. S. Sabnis	..	
*Dr. G. P. Majumdar	..	
Dr. B. P. Pal	..	
Prof. A. C. Joshi	..	
Prof. S. L. Ajrekar	..	*Past Recorder who are either Ordinary or Honorary Members.*
Prof. M. Sayeed-ud-Din		
Prof. F. R. Bharucha	..	
Dr. P. Anand	..	
Mr. N. K. Tiwary	..	
Dr. S. N. Das Gupta	..	
Prof. J. C. Sen Gupta	..	
Dr. T. S. Mahabale	..	
Dr. P. K. Sen	..	
Dr. B. C. Kundu	..	

7. **Zoology and Entomology**—

*Prof. A. B. Misra	..	*Convener.*
Dr. D. V. Bal	..	*Recorder.*
Mr. J. N. Rudra	..	*Sectional Correspondent.*
Mr. M. A. Majeed	..	*Local Sectional Secretary.*

Dr. H. D. Srivastava .. Dr. M. Sharif	*Elected Members.*
Prof. K. N. Bahl .. .. Dr. B. Prasad .. .. Dr. H. R. Mehra .. .. Dr. S. L. Hora .. .. *Dr. B. Sundara Raj .. .. Prof. D. R. Bhattacharyya .. Prof. R. Gopala Aiyar .. Diwan Anand Kumar .. Prof. H. K. Mookerjee .. Prof. B. K. Das .. .. Dr. G. S. Thapar .. .. Prof. A. Subba Rau .. .. Prof. M. Afzal Husain .. Rao Bahadur Y. Ramchandra Rao Dr. B. N. Chopra .. .. Prof. Vishwa Nath .. .. Mr. D. Mukerjee .. .. Dr. H. N. Ray .. .. Dr. M. A. Moghe .. .. Dr. G. D. Bhalerao	*Past Presidents who are either Ordinary or Honorary Members.*
Prof. S. G. M. Ramanujam .. Mr. Beni Charan Mahendra .. Dr. B. R. Seshachar .. .. Dr. P. Sen .. .. Dr. M. L. Bhatia .. .. Dr. M. Rahimulla .. .. Mr. D. Ganguli	*Past Recorders who are either Ordinary or Honorary Members.*

8. **Anthropology and Archaeology**—

Mr. A. Chatterjee	*Convener.*
Dr. P. C. Biswas	*Recorder.*
Mr. S. S. Sarkar	*Sectional Correspondent.*
Mr. S. A. Shere	*Local Sectional Secretary.*
Mr. Anil Chowdhury .. Mr. S. P. Roy	*Elected Members.*
Prof. P. C. Mahalanobis .. Dr. J. H. Hutton .. .. Dr. B. S. Guha .. .. Prof. K. P. Chattopadhyay .. Dr. G. S. Ghurye .. .. *Dr. D. N. Majumdar .. *Mr. T. C. Das .. .. Dr. H. H. Krishna .. .. Dr. N. P. Chakravarti .. * Dr. A. Aiyappan .. .. *Dr. (Mrs.) Irawati Karve ..	*Past Presidents who are either Ordinary or Honorary Members.*

Dr. G. M. Kurulkar	*Past Recorders who are either Ordinary Honorary Members.*
Capt. R. N. Basu	
Mr. T. C. Roy Chowdhuri ..	
Mr. D. Sen	
Mr. N. Dutta-Majumdar ..	
Dr. H. D. Sankalia	

9. Medical and Veterinary Science.—

*Dr. G. D. Bhalerao	*Convener.*
Dr. S. K. Basu	*Recorder.*
Dr. Arun Ganguli . ..	*Sectional Correspondent.*
Prof. B. N. Prasad . ..	*Local Sectional Secretary.*
Dr. J. C. Ray . .	*Elected Members.*
Dr. C. R. Das Gupta .	
Sir R. N. Chopra . .	*Past Presidents who are either Ordinary or Honorary Members.*
Lt.-Col. S. S. Sokhey	
*Mr. A. C. Ukil ..	
*Dr. C. G. Pandit .. .	
Prof. K. V. Krishnan	
Dr. S. W. Hardikar .. .	
RaiBahadur K. N. Bagchi ..	
*Prof. G. Panja	
Dr. M. B. Soparkar	*Past Recorders who are either Ordinary or Honorary Members.*
Dr. Phanindranath Brahmachari	
Mr. M. R. Mahajan	
Prof. G. Sankaran	
Mr. D. V. S. Reddy	
Dr. M. V. Radhakrishna Rao ..	

10. Agricultural Sciences—

Rai Bahadur Kalidas Sawhney ..	*Convener.*
Dr. R. S. Vasudeva	*Recorder.*
Dr. Hiran C. Chaudhuri ..	*Sectional Correspondent.*
Mr. B. N. Sinha	*Local Sectional Secretary.*
Dr. B. P. Pal	*Elected Members.*
Dr. B. T. Narayana	
Sir T. S. Venkataraman ..	*Past Presidents who are either Ordinary or Honorary Members.*
Sir T. Vijayaraghavacharya ..	
Prof. M. Afzal Hussain ..	
Mr. A. K. Y. Narayan Aiyer ..	
Dr. B. Viswanath	
Rao Sahib T. V. Ramakrishna Ayyar	
Prof. Jai Chand Luthra ..	
Mr. K. Ramiah	
Dr. Nazir Ahmad	
Rao Bahadur Y. Ramchandra Rao	
Dr. D. V. Bal	
Prof. N. V. Joshi	
Rao Bahadur V. Ramanatha Ayyar	
Mr. N. L. Dutt	

Dr. S. V. Desai	Past Recorders who are either Ordinary or Honorary Members.
Dr. A. N. Puri	
Dr. C. N. Acharya	
Dr. J. K. Basu	
Dr. T. V. Sukhatme	
Dr. B. L. Chona	
Dr. S. P. Ray Chaudhuri	

11. **Physiology** –

*Dr. Bashir Ahmad	*Convener.*
Miss Kamala Bhagwat	*Recorder.*
Dr. N. N. Das	*Sectional Correspondent.*
Dr. M. Shah	*Local Sectional Secretary.*
Dr. S. Banerjee	*Elected Members.*
Dr. M. C. Nath	
Prof. W. Burridge	*Past Presidents who are either Ordinary or Honorary Members.*
Lt. Col. S. L. Bhatia	
Sir R. N. Chopra	
*Prof. N. M. Basu	
*Dr. B. B. Dikshit	
Rao Bahadur B. T. Krishnan	
*Prof. Narayana	
*Prof. S. N. Mathur	
*Dr. B. Mukerji	
Prof. P. De	
*Prof .S. A. Rahman	
Mr. K. Mitra	*Past Recorders who are either Ordinary or Honorary Members.*
K. P. Basu	
Mr. B. Chatterji	
Prof. Khem Singh Grewal	
Mr. M. L. Chatterjee	
Prof. G. K. Ghosh	

12. **Psychology and Educational Science**—

Dr. Zakir Husain	*Convener.*
Prof. T. K. N. Menon	*Recorder.*
*Mr. D. Ganguly	
Prof. H. P. Maiti	
Mrs. S. K. Chatterjee	*Elected Members.*
Mrs. S. Deb	
*Mr. N. S. N. Sastry	*Past Presidents who are either Ordinary or Honorary Members.*
Prof. G. S. Bose	
Dr. S. C. Mitra	
Mr. J. M. Sen	
Mr. K. C. Mukherji	
Prof. H. P. Maiti	
*Dr. I. Latif	
*Dr. G. Pal	

Prof. B. L. Atreya ..	..	
Sir John Sargent ..	..	
*Dr. B. Kupuswamy ..	..	
*Dr. Indra Sen ..	..	
Mr. P. S. Naidu ..	..	
Mr. S. K. Bose ..	..	*Past Recorders who are either Ordinary Honorary Members.*
Mr. S. Sinha ..	..	
Mr. Pars Ram ..	..	

3. **Engineering and Metallurgy—**

*Mr. N. Sen ..	..	*Convener.*
Prof. M. Sen Gupta ..	..	*Recorder.*
Mr. J. Ganguly ..	..	
Mr. Bhagwat Prasad	..	
Mr. G. C. Mitter ..	..	
*Dr. A. H. Pandya ..	..	*Honorary Members.*
Mr. N. V. Modak ..	..	
Sir Jehangir Ghandy	..	
Rai Bahadur A. N. Khosla	..	
Mr. H. P. Kutar ..	..	
Mr. H. P. Kutar ..	..	
Mr. H. P. Bhaumik ..	..	
Prof. H. L. Roy ..	..	*Past Recorders who are either Ordinary or Honorary Members.*
Dr. S. K. Sircar ..	..	

Sub-Committee on Science and its Social Relations.

1-4. President, two General Secretaries and Treasurer (*ex-offici*).
5-17. Sectional Presidents of 13 Sections.

18. Prof. K. Banerjee (Calcutta).
19. Mr. A. N. Basu (Calcutta).
20. Dr. Gilbert Fowler (Bangalore).
21. Prof. D. D. Kasambi (Bombay).
22. Mr. P. H. Kutar (Jamshedpur).
23. Dr. H. K. Mitra (Jamshedpur).
24. Dr. K. Motwani (Karachi).
25. Dr. B. Mukerji (Calcutta).
26. Prof. M. N. Saha (Calcutta).
27. Prof. Benoy Kumar Sarkar (Cal.)
28. Dr. W. D. West (Calcutta).
29. Mr. A. C. Ukil (Calcutta), *convener.*
30. Mr. D. N. Wadia (New Delhi).
31. Dr. D. M. Sen (New Delhi).
32. Prof. J. M. Sen (Calcutta).

4 LOCAL RECEPTION COMMITTEE.

PATRON

His Excellency Sri Jairamdas Daulatram, Governor of Bihar.

CHAIRMAN

Lt.-Col. Sir Chandreshwar Prasad Narayan Singh, Kt., C.I.E., M.A., Vice-Chancellor, Patna University.

VICE-CHAIRMEN

The Hon'ble Mr. Sri Krishna Sinha, Prime Minister.
The Hon'ble Mr. Anugrah Narayan Sinha, Minister of Finance, Labour, Supply and Price Control.

The Hon'ble Dr. Saiyid Mahmud, Minister of Development.
The Hon'ble Mr. Jaglal Chowdhury, Minister of Excise and Public Health.
The Hon'ble Mr. Ram Charitar Singh, Minister of Irrigation, Public Health, Electrification and Legislature.
The Hon'ble Mr. Badri Nath Verma, Minister of Education and Information.
The Hon'ble Mr. Krishna Ballabh Sahay, Minister of Revenue and Forest.
The Hon'ble Mr. Benodanand Jha, Minister of Local Self-Government and Medical Department.
The Hon'ble Mr. Abdul Quaiyum Ansari, Minister of Public Works Department and Cottage Industries.
Dr. Sir Saiyid Sultan Ahmad, Kt., K.C.S.I.
Dr. Sir Khaja Muhammad Noor Kt.
Dr. Sachchidananda Sinha, D. Litt., D.L.
Sir J. J. Ghandy, Kt., C.I.E.
Dewan Bahadur Radha Krishna Jalan.
Shri S. P. Jain.
Mr. Mahabir Prasad, Barrister-at-Law.

LOCAL SECRETARIES

Dr. B. Narayana, M.Sc., M.B., Ph.D., F.R.S.E., F.N.I., Principal, P.W. Medical College, Patna.
Dr. P. B. Ganguly, D.Sc., F.N.I., Principal, Science College, Patna.

MEMBERS

Mr. P. P. Agarwal, M. Sc., (Luck.), B.A. Hons. (Cantab.), I.C.S.
Mr. Saiyid Mobarak Ali.
Mr. N. Baksi, C.I.E., M.A., I.C.S.
Dr. T. N. Banerji, C.I.E., M.R.C.P.
Mr. M. S. Bhattacharyya.
Major J. Curran, M.B., Ch.B. (N.U.I.), D.T.M. & H. (N.U.I.).
Prof. D. Chatterjee M.A.
Dr. S. Chatterjee, M.B., D.P.H., D.T.M.
Lt.,-Col. A. N. Duggal.
Prof. P. N. Das Gupta, M.Sc., Ph.D. (St. Andrews).
Dr. Madhusudhan Das, M. B., M.R.C.P., D.M.R.E.
Prof. M. Q. Doja, B.Sc., (Pat.), B.A., (Cantab.), A.R.P.S.
The Hon'ble Mr. Justice S. K. Das, I.C.S.
Mr. P. R. Das, Barrister-at law.
Dr. S. M. Ghosal, F. R.C.P. (Edin.), D.Ch. (Eng.), M.R.C.P. (Lond.).
Dr. U. P. Gupta, M.R.C.O.G.
Dr. A. K. Guha, B.Sc., M.B., B.S., T.T.M. (Liv.), D.Ch. (Eng.), M.R.C.P. (Edin.)
Prof. L. A. N. Iyer, Ph.D. (London), D.I.C.
Dr. G. K. Ghosh, M.Sc., B.A., M.B.
Rai Bahadur Dr. S. K. Ghosh Dastidar, M.R.C.P., D.T.M. (Cal.)
Dr. (Miss) M. P. John, M.R.C.O.G.
Dr. K. R. Krishnaswami, D.Sc., (Lond.) F.R.I.C.
Shree Rai Brij Raj Krishna, B.L.
Mr. Abdus Samad Khan, C.I.E., M.Sc., (Manchester), I.E.S. (Retd.).
Prof. H. P. Maiti, M. A.

Mr. S. K. Mitra, Barrister-at-law.
Dr. K. P. Mitra, M. B.
Mrs. Ramola Nandi, M.A.
Mr. Trilok Nath, B.A., I.P.
Prof. N. S. Rao Nagendra Nath, Ph.D. (Cantab).
Lt.-Col. D. P. Nath, M. B., Ch. B. (Edin.)
Mr. H. K. Nivas, F. Inst. M.E., M.I.E. (India), I.S.E.
Dr. J. S. Patel, B.Sc., M.Sc., (Cantab.), Ph.D. (Edin.), F.A.S.C.
Prof. Lala Mukund Murari Prasad, M.A.
Mr. Ragkunandan Pande, M.A.
Mr. Rajkishore Prasad, M.A., B.L.
Mr. Nageshwar Prasad, M.A., B.L.
Mr. K. Prosad, O.B.E., B.A. (Cantab.)
Mr. Mahabir Prasad, B.Sc.,
Mr. Jaideva Prasad, M.L.C.,
Dr. Sidheshwar Prasad, M.B., B.Sc.
Dr. Gaya Prasad, M.D., M.R.C.P., D.C.P. (Eng.). D.T.M. (Liv.), D.Ch. (Eng.).
Dr. B. N. Prasad, M.Sc., M.B., Ph.D., F.R.S.E.
Rai Bahadur N. Prasad, A.I.S.M., A.S.M.E.
Dr. Sarju Prasad.
Shree Shastri Bhola Paswan, M.L.A.
Dr. Dukhan Ram, B.Sc., M.B., D.L.O., D.O.M.S. (Lond.).
The Hon'ble Mr. Justice D. E. Reuben, I.C.S., Barrister-at-law.
Mr. A. C. Ray, B.Sc., B.L.
Mr. B. N. Sarkar O.B.E.
Mr. Baldeva Sahay, M.A., B.L.
Rai Bahadur R. P. N. Sahi, B.A.
Mr. Tribeni Prasad Singh, M.Sc., I.C.S.
Dr. S. Samaddar, M.B., B.S.
Kumar Ganganand Sinha.
Mr. P. R. Sen, B.Sc., B.L.
Mr. S. K. Sen, B.Sc., (Cal.), M.R.C.V.S.
Mr. Gorakhnath Sinha, M.A., B.A. (Cantab.)
Mr. L. P. Singh, M.A., I.C.S.
The Hon'ble Mr. Justice B. P. Sinha.
Mr. T. P. Singh, B.A., I.C.S.
Mr. Bijon Behari Sen, M.A.
Mr. Sri Narayan Sahay, Barrister-at law.
Mr. Akhauri Sachchidanand, M.Sc., I.P.
Dr. R. Saran, M. R.C.P.
Dr. Paras Nath Singha, M.B., B.S., D.L.O.D.O.M.S. (Lond.).
Dr. V. N. Singh F.R.C.S. (Eng.)
Mr. Pandey Ramcharan Sahay, M. A., B.L.
Rai Bahadur Shyamnandan Sahay, C.I.E., M.L.A.
Mr. Phulan Prasad Verma, M.A., B.L.

5. ARRANGEMENTS FOR THE THIRTY-FIFTH SESSION.

The Local Reception Committee made all local arrangements necessary for the transaction of the scientific works of the session as well as for accomodation of the members and delegates who attended the Session.

6. LIST OF DELEGATES.

FOREIGN

UNITED KINGDOM

(*British Association for the Advancement of Science*)

Professor Alexander Findlay

AUSTRALIA

Sir John Madsen (*Chairman of the Australian Delegation*)
Sir Kerr Grant
Prof. J. A. Prescott
Mr. R. G. Thomas
Mr. G. B. Gresford (*Secretary to the delegation*).

U.S.A.

Dr. W. A. Shewhart, Statistician, Bell, Telephone Laboratories, New York.

NORWAY

Dr. Sverre Petterssen, Meteorologist, Oslo, Narway.

MEXICO

Dr. M. S. Vallarta, Physicist, Buenos Aires Mexico.

BURMA

Mr. U. Po. Tha. (Rangoon University).

Mr. U. Saw Tun. (*Department of Industries Govt. of Burma*).

Leaı ned Societies.

Calcutta Mathematical Society	..	Prof. F. W. Levi. Prof. P. N. Das Gupt Prof. M. R. Siddiqui. Prof. B. B. Sen. Mr. U. R. Burman.
Entomological Society of India	..	Dr. H. S. Pruthi, New Delhi. Dr. K. D. Baweja, New Delhi. Dr. K. B. Lal, Cawnpore.
Indian Botanical Society	..	Dr. A. C. Joshi, Delhi. Dr. P. Maheshwari, Dacca. Dr. S. N. Das Gupta, Lucknow. Prof. M. O. P. Iyengar, Madras. Prof. G. P. Majumdar, Calcutta. Prof. Shree Ranjan, Allahabad. Dr. R. L. Nirula, Nagpur. Prof. S. P. Agharkar, Bombay. Prof. Y. Bhardwaja, Benares. Dr. T. S. Sadasivan, New Delhi.
Indian Chemical Society	..	Dr. S. Krishna, Dehra Dun. Dr. V. Subrahmanyan, Bangalore.

Indian Statistical Institute	Sm. Chameli Bose.
	Sri N. T. Mathew.
	Sri P. Banerjee.
	Sri S. N. Roy.
	Prof. K. N. Chakravarti.
	Sri A. Das.
	Sri D. M. Ganguly.
	Sri. S. B. Sen.
Institution of Engineers (India) ..	Mr. H. P. Bhaumik.
	Mr. J. Datt.
	Mr. B. V. Vagh.
	Mr. P. V. S. Iyengar.
	Dr. K. C. Chakko.
	Major D. L. Deshpande.
National Institute of Sciences of India ..	Sir S. S. Bhatnagar, Delhi.
Royal Asiatic Society of Bengal ..	Dr. W. D. West, Calcutta.
	Lt. Col. C. L. Pasricha, Calcutta.
National Council of Education, Bengal ..	Dr. H. L. Roy.
	Prof. S. N. Mookherjee.
	Dr. J. N. Basu.
	Dr. S. Deb.

Universities.

Allahabad University	Prof. S. Ranjan.
	Prof. A. C. Banerji.
	Prof. N. R. Dhar.
	Dr. H. R. Mehra.
	Dr. B. N. Prasad.
Andhra University	Prof. S. Bhagavantam.
	Prof. T. R. Seshadri.
	Prof. C. Mahadevan.
	Rao Saheb C. J. Dasarao.
	Dr. T. Venkatarayudu.
	Dr. M. Narasinga Rao
Benares Hindu University	Prof. S. S. Joshi.
	Prof. Rajnath.
	Prof. B. Dasannacharya.
	Prof. Y. Bharadwaja.
	Prof. A. B. Misra.
	Prof. V. V. Narlikar.
	Prof. H. L. Chhibber.
Bombay University	Dr. K. G. Naik, Ahmedabad.
	Dr. G. M. Nabar, Bombay.
Calcutta University	Prof. M. N. Saha.
	Prof. P. Ray.
	Prof. H. K. Mookerji.
	Prof. B. C. Guha.
	Prof. B. B. Sarka
	Mr. N. N. De.
	Mr. S. N. Roy.

	Mr. P. K. Basu.
	Mr. H. K. Nandi.
	Mr. D. N. Ganguli.
	Mr. N. N. Chatterjee.
Dacca University	Prof. N. M. Basu.
	Dr. S. R. Khastgir.
	Dr. A. K. Dutt.
	Mr. Q. M. Hussain.
	Dr. Tarapada Banerjee.
	Dr. H. N. De.
	Dr. P. Maheswari.
	Mr. Ashraful Haq.
Lucknow University	Mr. R. P. Agarwal.
	Mr. S. S. Srivastava.
	Mr. B. S. Tewari.
	Dr. A. C. Chatterjee.
	Dr. S. A. Faseeh.
	Dr. Ram Gopal.
	Dr. P. N. Sharma.
	Dr. K. N. Bahl.
	Dr. A. B. Sen.
	Mr. L. N. Srivastava.
	Dr. B. P. Yadava.
	Mr. Kali Prasad.
	Mr. R. M. Lomba.
	Mr. Hakim Iftikhar Ali
	Dr. S. N. Mathur.
	Dr. Ram Ballabh.
	Dr. G. S. Varma.
	Dr. R. C. Misra.
Madras University	Dr. M. Damodaran.
	Dr. R. Vaidyanathaswami.
	Dr. C. P. Gnanamuthu.
	Dr. George Kuriyan.
	Dr. G. D. Boaz.
	Sri T. V. Desikachari.
	Sri L. A. Krishna Iyer.
	Sri D. V. Rajalakshman.
Muslim University, Aligarh	Dr. M. Omur Farooq.
	Dr. Mohd. Afzal Husain Qadri.
Mysore University.	Mr. K. Subramanyam, Bangalore.
	Dr. N. S. Narayana Sastri, Mysore.
	Mr. M. Abdul Hafeez, Mysore.
	Mr. S. Siddappa, Bangalore.
	Mr. R. N. Nanjundappa, Bangalore.
	Mr. K. Narayan, Bangalore.
Nagpur University	Mr. G. V. Asolkar.
	Dr. A. N. Kappanna.
	Mr. A. Gopal Krishna.
	Mr. K. Sripada Rao.
	Dr. M. C. Nath.
	Dr. R. L. Nirula.

Travancore University	Rajyasevapravina Dr. K. A. Moudgill. Dr. H. Subramonia Aiyar. Dr. U. Sivaraman Nair. Mr. T. R. M. Lawrie. Dr. C. S. Venketeswaran. Mr. T. K. Koshy. Mr. Ittyerah Joseph. Mr. C. V. Kurien. Mr. R. Velayudhan Nair. Dr. C. C. John. Mr. P. G. Nilakanta Pillai. Mr. Srimulanathan.
Utkal University.	Dr. P. Parija, Cuttack.

RESEARCH INSTITUTIONS AND COLLEGES

Carmichael Medical College, Calcutta ..	Mr. S. K. Sen. Mr. Sambhunath Mukherjee.
Forest Research Institute & College, Dehra Dun	Dr. K. D. Bagchee. Dr. S. V. Puntambekar. Dr. K. A. Chowdhury. Dr. D. Narayanamurti. Dr. A. Purshotam. Mr. M. B. Raizada.
Government of India, Delhi Polytechnic ..	Mr. S. C. Sen. Dr. T. N. Mehta.
Fuel Research Institute, Dhanbad.	Dr. J. W. Whitakar. Dr. A. Lahiri.
Scientific Research Committee, U.P. Allahabad	Dr. Satya Prakash, Allahabad.

GOVERNMENT OF INDIA, PROVINCIAL GOVERNMENTS AND STATES

Anthropological Survey of India, (Govt. of India), Benares.	Mr. A. K. Mitra. Mr. B. C. Gohain.
Government of India, Office of the Director-General of Archaeology	Mr. A. Ghosh, Patna. Mr. J. H. S. Weddington, Calcutta. Dr. S. Paramasivan, Tanjore. Mr. B. B. Lall, New Delhi.
Government of India, Ministry of Education ..	Dr. P. D. Shukla, New Delhi. Dr. S. R. Sen Gupta, New Delhi. Dr. N. P. Mukherjee, New Delhi.
Government of India, Ministry of Food ..	Dr. D. V. Karmakar, New Delhi.
Government of India, Office of the Director-General of Health Services	Dr. K. C. K. E. Raja., New Delhi. Dr. B. Mukerji, Calcutta.

Government of India, Office of the Chief Superintendent Technical Development Establishment Instrument and Electronic). Dehra Dun.	Dr. K. Mitra, New Delhi. Dr. C. S. Rao, Dehra Dun. Mr. R. K. Tandan, Dehra Dun.
Government of United Provinces, Department of Economics and Statistics	Mr. J. K. Pande, Lucknow.
Government of United Provinces, Finger Print Bureau and Scientific Section, C.I.D. ..	Mr. S. R. Gupta, Allahabad.
Government of Assam, Office of the Director of Agriculture, Shillong	Dr. S. K. Talapatra, Gauhati.
Government of India, Office of the Director of Industries, Shillong	Sri. I. N. Hazarika, Jorhat.
Gwalior Government, Department of Industries, Commerce and Communications ..	Mr. V. D. Jawalikar, Gwalior.
Jaipur Government, Development Minisry. ..	Mr. D. M. Bhandari, Jaipur.
Jaipur Government, Department of Statistics	Mr. H. C. Kothari, Jaipur.
Government of Jodhpur, Director of Education	Dr. K. N. Kini, Jodhpur.
Rewa State, Office of the Secretary, Local Self-Government, Rewa	Mr. Gopal Prasad Khare, Rewa.
Office of the Superintendent of Education, Delhi, Ajmer-Merwara and Central India, Delhi	Dr. A. N. Banerji, Delhi.

COMMERCIAL BODIES

Indian Mining Federation, Calcutta ..	Sri D. D. Thacker, Jharia. Sri P. Basu, Calcutta. Sri B. N. Banerjee, Calcutta. Sri Narendra Singh Singhee, Calcutta.

7. PROGRAMME OF THE SESSION

The thirty-fifth session of the Indian Science Congress was held at Patna under the auspices of the Patna University from January 2 to 8, 1948.

The inaugural meeting was held on Friday, January 2, 1948 at 2 P.M. in a pandal especially erected for the purpose in at the University grounds, Patna, in the presence of a large number of delegates, members and visitors. Foreign scientists from Australia,

American, and England were also present. After Vandemataram song, Lt. Col. Sir C. P. N. Singh, Kt., M.A., C.I.E., M.L.A., Vice-Chancellor, University of Patna as Chairman of the Local Reception Committee welcomed the delegates, members and visitors and requested His Excellency Shri Jairamdas Daulatram, the Governor of Bihar and Chancellor of the Patna University, to open the Session of the Congress. After His Excellency had opened the proceedings of the Session, Prof. P. C. Mahalanobis, one of the General Secretaries of the Indian Science Congress, introduced Prof. Alexander Findlay (England), Dr. W. A. Shewhart (U.S.A.) and members of the Australian delegation: Sir John Madsen (Chairman of the delegation), Sir Kerr Grant, Prof. J. A. Prescott, Mr. R. G. Thomas and Mr. G. B. Gresford (*Secretary to the delegation*). Prof. Mahalanobis stated that Dr. S. Petterssen, Norweigian Meteorologist and Dr. M. S. Vallarta, a Mexican Physicist could not attend the inauguration of the session since they could not reach Patna by plane though they had arrived in Calcutta. He then announced that greetings from Canada and British Association for the Advancement of Science had been received. He also said that the Australian delegation headed by Sir John Madsen brought the good wishes of Australian Scientists and Universities for the success of the session and progress of science in India.

Dr. P. B. Ganguly, Principal, Science College, Patna and one of the Local Secretaries, read out messages from Pandit Jwaharlal Nehru who regretted that he could not attend the Congress but he extended his personal and the Central Government's greetings to Scientists who had gathered at Patna for the session of the Congress from all corners of India and other parts of the world. Messages were also read from Ba Sein from Burma, Sir J. C. Ghosh, Sir S. S. Bhatnagar, Dr. Jivaraj Mehta and others who could not attend the session due to illness, sent a message of goodwill from his sick bed.

In the absence of Sir Ram Nath Chopra, Sir C. V. Raman, a senior past-President of the Congress was requested to deputise for him who then read out certain portions from the Presidential Address of Col. Sir Ram Nath Chopra.

The PRESIDENTIAL ADDRESS of the Sections were delivered as follows:—

Saturday, January 3: 10-30A.M., Statistics; 11 A.M., Physics; 11-30 A.M., Agricultural Sciences; 12 A.M., Psychology and Educational Science.

Monday, January 5: 10 A.M., Physiology; 10-30 A.M., Engineering and Metallurgy; 11 A.M., Geology and Geography; 11-30 A.M., Botany; 12 A.M., Chemistry.

Tuesday, January 6: 10 A.M., Mathematics; 11 A.M., Anthropology and Archæology; 12 A.M., Medical and Veterinary Sciences.

Wednesday, January 7: 10 A.M., Zoology and Entomology.

DISCUSSIONS

Saturday, January 3: 11 A.M. to 1 P.M. and 4 P.M. to 5-30 P.M.

Subject	Section
1. The forecast of crop yields from the study of weather conditions ..	Statistics jointly with Agricultural Sciences.
2. Food and World Population ..	Organised by the Sub-Committee on Science and its Social Relations.
Monday, January 5: 10 A.M. to 1-30 P.M.	
3. Upper Air	Physics.
4. Quality Control in Industrial Output	Engineering and Metallurgy jointly with Statistics.

Tuesday, January 6: 10 A.M. to 1 P.M. and 2 P.M. to 3-30 P.M.

5. Psychological Service in Schools ..	Psychology and Educational Science.
6. Recent advances on the cause and treatment of diabetes	Physiology jointly with Medical and Veterinary Sciences and Chemistry.
7. Planning of National Health Surveys	Statistics jointly with Medical and Veterinary Sciences.
8. Role of Electronics in Modern Engineering Practice	Engineering and Metallurgy.

Wednesday, January 7: 10 A.M. to 1 P.M.

9. Physiological Basis of Health and Longevity	Physiology jointly with Medical and Veterinary Sciences.

MEETINGS OF COMMITTEES

Council met on January 1 at 3-30 P.M. and again on January 3 at 7-30 P.M.
Executive Committee met on January 1 at 2-30 P.M. and again on January 3 at 7 P.M. and on January 5 at 2 P.M.
Sub-Committee on Science and its Social Relations met on January 2 at 11 A.M.
Sectional Committees met on January 3, 5, 6 and 7 at 9-30 A.M.
General Committee met on January 5 at 2-30 P.M.

SOCIAL FUNCTIONS

January 2: 'At Home' by Maharajadhiraj of Darbhanga at 4-30 P.M. in the Science College Grounds.

January 3. 'At Home' by the Vice-Chancellor and Members of the Patna University at 4-30 P.M. in the Science College Grounds.

January 5: 'At Home' by Dewan Bahadur Radha Krishna Jalan at 4 P.M. in the Quilla House, Patna City.

January 6: Variety Entertainment at 8-45 P.M. in the Lady Stephenson Hall.

January 7: Cinema show at 8 P.M. in the Physics Lecture Theatre, Science College.

POPULAR LECTURES

January 2:

'Possibilities of Research in the Chemistry of the sensation of tests and smell' by Sir C. V. Raman, Bangalore.

'Atomic Age' by Prof. M. N. Saha, Palit Professor of Physics, Calcutta University.

January 3:

'Infra-red Spectrum' by Sir C. V. Raman, Bangalore.

January 5:

'Quality control in Industry' by Dr. W. A. Shewhart, Statistician, Bell Telephone Laboratories, U. S. A.

'Story of Diamond' by Sir C. V. Raman, Bangalore.

January 6:

'Science and the Community' by Prof. Alexandar Findlay, Emeritus Professor of Chemistry, University of Aberdeen and past President of the Royal Institute of Chemistry, London.

January 7:

'Land of the Midnight Sun' by Dr. Sverre Peterssen of the Norwegian Meteorological Service, Oslo (Norway).

"Cosmic Rays" by Prof. M. S. Vallarta, Professor of Physics, University of Mexico, Buenos Aires.

WHOLEDAY EXCURSIONS

Rajgir, Nalanda and Gaya.

January 4:

January 8:

Dalmianagar.

LOCAL EXCURSIONS

January 7:

Batanagar, Hindusthan Bicycle Factory and Patna School of Arts.

ANNUAL MEETINGS OF LEARNED SOCIETIES

January 1:

1. The National Institute of Sciences of India.
2. Institution of Chemists (India).
3. Society of Biological Chemists (India).
4. All-India Nutrition Board.
5. Indian Society of Soil Science.
6. Indian Ecological Society.
7. Association of Microbiologists of India.
8. Indian Society of Genetics and Plant breeding.
9. Entomological Society of India.
10. Indian Phytopathological Society.
11. Royal Institute of Chemistry of Great Britain and Ireland (Indian Section).
12. Indian Chemical Society.
13. Indian Ceramic Society.
14. Physiological Society of India.
15. Museum Association of India.
16. Indian Botanical Society.
17. Indian Physical Society.
18. Indian Psychological Association.
19. Indian Zoological Society.
20. Institution of Engineers (India).

January 2:

21. Indian Psychiatric Society.
22. Inaugural Meeting of the Institute of Fuel, London (Indian Branch).
23. Indian Pharmaceutical Association.
24. Association of Indian Geographers.

January 4:

25. Association of Scientific Workers.

8. OPENING PROCEEDINGS

Lt. Col. Sir Chandreshvar P. N. Singh, Vice-Chancellor of the University of Patna and Chairman of the Reception Committee delivered the following welcome address on January 2, 1948.

Welcome Address:—

Your Excellency, President & Members of the Indian Science Congress, Ladies & Gentremen,

On behalf of the University of Patna and the people of Bihar, it gives me very great pleasure indeed to welcome you, members of the Indian Science Congress, Delegates, Guests and visitors, to this ancient city of Pataliputra. To our infinite regret, and to his own, Pandit Jwaharlal Nehru has not found it possible to leave Delhi where urgent affairs of State demand him, and his visit to Patna had, therefore, to be cancelled almost at the last moment. We shall miss his inspiring presence and guidance; for the Indian Science Congress is dear to him, as it should be, for in this twentieth century it is to men of science and to men imbued with the scientific spirit that Man turns for guidance in the building up of a brave new world.

The province to which I welcome you all has a rich and a hoary past. Associated with the hallowed name of the Buddha, of Chandragupta and Asoka, Magadha in ancient times was also famous for its men of science and of learning. At Nalanda, not far from here, was one of the most famous Universities of olden times, where seekers after truth and knowledge fore-gathered at the feet of Sages and Savants. From the ends of a far-flung empire, across the Hindu Kush and the Himalayas, came pilgrims to the land of the Buddha, and scholars to the *ashramas* of Sheelbhadra and Nagarjuna. Science, even material science as it is sometimes erroneously called, flourished at Nalanda, where knowledge was sought both a s a means and as an end.

The past has an attraction all the greater to a nation which cannot bear to contemplate the present; but pre-occupation with the past, however glorious, becomes as escape and a snare. A glorious past should be an incentive to action, to progress towards the realization of a future, equally glorious, if not more. The past is beyond recall, the future is in our hands. In the world of to-day, we have to apply ourselves to the study of physical and natural sciences with much greater energy and earnestness than hitherto. I am convinced that the keenness and subtlety of the Indian intellect, which, made India the chosen home of wisdom and learning, will once again take her to the van of those nations which are now justly regarded as leaders in the evolution of Humanity. This great task, a task which once clearly recognised cannot possibly be declined, devolves on our universities, and on our scientific societies, and on the Indian Science Congress Association in particular.

We are living to-day in a world that threatens to brush aside reason and intelligence. Two great wars and the prospect of more; a majority of the population of the earth caught in the eddy of destruction; years of disappointment and dejection, millions everywhere without food, clothing and shelter; a confusion over issues and values which leaves men frustrated and uncertain is it any wonder that Man seeks expedients that Force provides, rather than the guidance that reason gives? The chief temptation is that force seems to provide such an easy answer. It appears to cut through complexity and confusion, without the severe intellectual effort and discipline necessary for any effective alternative. The tragedy is not that so many men in the world believe in force as a method of social organization, but that so many who reject force as an ideal actually surrender to it in practice; some consciously, as an expedient, many unconsciously; the many, while offering lip-homage to the processes of reason, are led by lack of well-directed effort to yield to advance pickets that, under a comouflage, force always employs to gain its ends. Catchwords, propaganda and slogans play upon man's emotion and prejudice, and appeal to his baser instincts of partnership and acquisitiveness. Force triumphs, and appears to be the only solution. In the end, force, however, always defeats

itself. In the long run it solves nothing and answers nothing It brings us no nearer to the prospect of a happy society, free from pain, passion and guilt, which science and culture reveal. If the world of the future is to be a more promising habitation for mankind it will only be as the result of persistent application, not of force, but of intelligence and reason against what now thwart mankind. Science has shrunk this world of ours and created a society so inter-dependent that the issues are no longer simple, individual, local or even national; they are complex, world-wide and beyond all past human experience. Peace and security, money and credit, fiscal policy, international relations, international trade and finance, national income and its distribution, wages, profits, prices, monopoly, purchasing power, savings and investment, employment and unemployment, social security, collective bargaining, housing and sanitation, public opinion, public administration, the relations between the State, industry and business, individual and adjustment, crime, social welfare, education, population, social justice in an interdependent society—this is a brief list of some of the urgent problems which face us to-day. Atom bombs cannot hope to solve such problems as these.

As the only effective alternative to rule by force, we have to make the hard choice that calls for vigorous intellectual effort to define and analyse the fundamental issues; these issues, unless narrowed down or defined by objective analysis, would freeze into ideologies, and thus shift from an intellectual to a purely emotional basis. In place of a creative struggle of facts and issues, conflict degenerates into a mere fight for power. If, however, by objective and scientific study, the issues are more precisely defined and the facts more exactly known, the conflicting views which might still remain can be more readily resolved, given a reasonable amount of good will. We cannot hope for adequate clarification of the economic and ethical questions of to-day until these issues are examined by the scientific method. The simple and antiquated technique and method of yesterday will not suffice. Highly specialized and complex methods are required. In the words of Lord Stamp: "Any truth is many-sided, even simple truth. But the complex truth of to-day needs approach by many different methods and by many different types of mind before we can arrive at even an approximation to the truth."

The simple fundamental truth that man has to live, and to live he needs food, clothing, shelter and an overall security, presents a problem that the modern world has not yet been able to solve. It may be that the solution has eluded us, because it has been sought for the benefit of a particular group of men—call it by whatever name you will, class, community, or nation,—and not for the benefit of man in general all the world over. It may also be that the solution has been found, but has lost its efficacy in the use made of it, and the quest has to begin once again. The crucial problem, therefore, facing the scientist of to-day is the use to which science and the technological processes perfected by science are put by those who have the power to use them. Truths discovered in the laboratory are either commercialized or militarized; to take one single instance of the latter—the use made of whatever knowledge of atomic structure we have been able to gain so far. From the time of the alchemists, the natural philosopher has tried to probe into matter of which our physical universe is made, in order to discover the nature of its smallest parts and the laws which govern them. The alchemist's dream of transmutation has now been partially realized. Since the turn of the present century a flood of light has been thrown on the nature of atomic structure. Nearly two and a half decades ago the inner citadel of this universe was successfully attacked by shooting into the atom small projectiles of such high speed that they disrupt the internal pattern. From a study of the erupted fragments, of the mutilated remainder and of the battered projectile, new knowledge was obtained of atomic structure. The only practical applica-

tion which unfortunately has till now been made of the enormous energy liberated by the fission of atoms has been in the making of the atom bomb, one of the most terrible weapons of destruction devised in modern times.

It is just this misuse of science by power-mad politicians and rulers of men that has exposed since to-day to sharp attack. The growing realization that science can be and has been used for man's enslavement and destruction has given rise to bitter questions and charges; and we read to-day of "civilization betrayed by science," and of "a degraded science that shirks the spiritual issues and hypnotizes its victims with its millions of gadgets." This has arisen, of course, because science as a technique for the understanding of nature is also a technique for gaining power, and power can be used by evil men to do evil, even more obviously and dramatically than it can be used by good men to do good.

The possibility of misuse, however, is not an argument for no use at all, and at present, when men's minds are swayed by emotion rather than by reason, the intellectual and moral progress of man can be best ensured by inculcating the scientific spirit which, in Einstein's words, may be defined as "scrupulous correctness and internal logical coherence."

In India to-day, after centuries of political subjugation and the consequent intellectual stagnation, the spirit and service of science are sorely needed. The Indian intellect, generally believed to be more assimilative than critical, with its "inherited traditions of thought," its dreamy and mystic imaginativeness, needs the severe discipline of the scientific spirit. It is true that as Man approaches the frontiers of knowledge, he needs as Plank pointed out, "imaginative vision and faith," in order to be able to proceed further and still further. But at all stages, he must also have, again in Planck's words, "the constructive quality of mind which builds up by a process of elimination and choice." It is this constructive quality of mind that India sorely needs to-day, to supplement its imaginative faith and vision; and our education has to be so re-oriented that the scientific spirit of intellectual discipline filters to the masses, and pervades all strata of society.

The Indian Science Congress Association, with its rich talent, can render national service of inestimable value if it can so remould our thought and habits of mind that we can emancipate ourselves from the dead weight of wornout traditions, of effete survivals of an unhealthy past. At the same time, it should also take special care that the power that knowledge brings is not used and exploited in the interest of a few and to the detriment of the many. They must not "permit themselves to become the conscious or unconscious instruments of militarists, imperialists and a ruling oligarchy of capitalistic or governmental bosses." They should link themselves up with scientists all the world over,—for science knows no national frontiers,—in a holy brotherhood, each member of which shall pledge himself that he shall "use knowledge for the good of humanity and against the destructive forces of the world and the ruthless intent of men." We in India have a subtle distinction between wisdom (*jnan*) and knowledge (*vidya*) and between those who are qualified for knowledge (*Vedadhikari*) and those who are not. Wisdom alone can teach man how to use the power that knowledge brings, and acquisition of wisdom should be end of all knowledge.

The time has come for an international body of scientists to control the release and distribution of scientific knowledge, specially such knowledge as may be used to perfect technological processes. The Indian Science Congress Association may easily become, under the guidance of Pt. Jwaharlal Nehru, the nucleus of an international controlling agency of the kind contemplated. India has never been either aggressive or intolerant, and its humanistic civilization makes it a fit and proper custodian of knowledge and

of wisdom. Its spiritual heritage, which even now colours its outlook, will be an effective safeguard against the impulse to conquer or to exploit weaker and defenceless nations. Thus, a brotherhood of humanists and scientists, working together for the welfare of humanity as a whole, might have its centre in India, whence, as from an inexhaustible fountain, knowledge will flow in fertilising channels all over the world, and India alone can prevent the knowledge acquired by *deva* from being misused by *danava*, the militarist and the enslaver. Speaking before an assemblage of leaders of thought, gathered at Patna from practically all over the civilized world, I am encouraged to suggest that we should, here and now, resolve to found an international agency for the control and dissemination of scientific knowledge. In recent years we have had patterns of international agencies for the control, distribution and use of material resources; is it such a utopian ideal to suggest an agency for the control and distribution of the power to use these resources? We have fortunately amongst us an eminent Indian, who is also a citizen of the world, who combines ardent patriotism with a rich warm humanism, whose broad international outlook makes him think in terms of entire mankind—'creation's heir.' Scientist and scholar, statesman and administrator, to whom else need we turn for guidance but to Pandit Jwaharlal Nehru?

Such an international agency is necessary now, for never before has the skein of human relations been so tangled, or the course of cause and effect so confused. The world-society of the twentieth century with its intricate web of interdependence presents a challenge to discipline intelligence such as no previous generation ever faced. At a time like this, for reason to surrender to bafflement, or for hope to lose itself in a panicky escape into passivity, is unthinkable. The race with confusion and complexity may be desparately close, but the spirit of Man will win, and his intelligence will and must succeed in finding correct answers to the urgent questions which confront him. These answers do not rest solely with any one group of thinkers. Economists, political scientists and administrators must all collaborate, and so must chemist, physicists, and biologists. So must humanists—historians, philosophers, artists, poets, novelists, dramatists—all those who fashion ideas, concepts and forms that give meaning and value to life, and furnish patterns of conduct both individual and collective. It is all of them who really construct the world we live in, and it is they who mith sensitive awareness to human perplexity and aspirations and with the power of imaginative perception can speak to a distracted world. We neel the light which more exact knowledge would bring, and I invite our scientists to hold aloft the torch.

After the welcome address, Sir Chandreshvar P. Singh requested His Excellency Sri Jairamdas Daulatram, Governor of Bihar, to open the Thirty-Fifth Session of the Indian Science Congress.

His Excellency the Governor of Bihar in declaring the Congress open delivered the following speech:—

Mr. President & Fellow seekers of Truth.

As I face this great galaxy of brilliant scientists. I ask myself whether I have any right to inaugurate a session of the Indian Science Congress, since I have had no closer contact with scientific studies than as a University student now many years ago. I hope it is not merely the high office I chance at present to hold which has led you to call upon me to perform this inaugural function of your Congress. But I would fain believe that your call is due to your appreciation of the great movement for freedom which reaches its culmination on the 15th of August last and of which, I happen to be a representative, an imperfect one though, I know. It is in that light that I have inter-

preted my part in to-day's function and hence regard it a privilege to inaugurate this session of India's Congress of Scientists.

You have assembled here from the four corners of this great land of ours and some of you from distant places all over the world have also honoured this gathering by your distinguished presence. All have come with the same great purpose. And that great purpose is to pool your knowledge, to expound and to learn, to gain the stimulus which contact with congenial spirits always gives, and to take with you at the end of your labours fresh enthusiasm for greater progress in human knowledge.

And yet, I know, you do not want to pursue the path of knowledge merely for the sake of knowledge. Science is not and has never been an end in itself. Each step taken by man up the endless spiral of knowledge has been instinctively to fulfil some urgent need, to satisfy some compelling urge.

A great German scientist, addressing the Royal Academy of Science nearly a century ago, re-declared the truth that "the history of physical science teaches us that our knowledge of things and of natural phenomena has, for its starting point the material and intellectual wants of man." Science has always served and must ever serve the needs of man. That is not only its objective but it is also its origin. Directly or indirectly, consciously or unconsciously, the needs of man are forcing his mind to probe more deeply, explore more widely into the never ending *terra incognita* of nature's limitless domain. There is no such thing as the accidental discovery of the tree of knowledge or an equally accidental eating of its fruit. Man has sought knowledge stirred by a purpose and impelled by an urge to move forward which is imbedded in the very stuff of which this universe is made, whether inanimate or animate.

In the dim distant past, millions of years ago, man developed the capacity to use products of nature to satisfy his physical needs. As these needs grew, his study and use of nature's products and nature's forces also progressed. The animal in man, yet his dominant feature, demanded at first the satisfaction of what the body required. Food for it, covering for it, shelter for it, adornment for it and other things for other needs of the body--these all instinctively guided man to the study of nature. Using and working on nature's products, and understanding vaguely the laws which governed its mighty forces, the brain of man evolved into a wonderful instrument capable of rationalization and all forms of reasoning. Other higher mental processes also came within the achievement of man. With this evolution of the mind, its needs also grew and man began to discover new ways of satisfying those subtler needs. The intellectual wants of man led to the study of the mind itself and a whole series of new sciences appeared on the scene. But is this process to terminate with our progress in mental sciences? Can you ever stop the great wheel of endless motion? Is that motion to be confined to things of the body and mind? Are these the only parts on a man's personality which are subject to dynamic change? Are there no dynamics of the spirit? May not the dialectics of the physical and the mental world hold true of other phases of human advance? Is not mankind feeling the need of progress in the moral sphere?

There is nothing that is static in this universe. There is nothing that is really inert and fixed. All that is moves, has always moved, will always be on the move. No feature of whatever can be sensed or inferred or intuitively realised by man is more characteristic than that everything that is, is in a state of continuous motion, is in the process of continuous change. The twinkling stars in the heavenly vault above, that light the human path in the desert and soothe the human spirit at night, though seemingly stationary at their places in their respective constellations since the ages, are rushing and whirling at terrific speeds, for which this grain of sand, we are pleased to call

our earth, has no parallel. The perfect circle of the great orb which is daily creating, sustaining, destroying and recreating life on this little globe, is in reality, an uneven mass of gas which swirls and revolves at a pace which the human brain is unable concretely to comprehend. The hard inert flint or steel or diamond or other fundamental elements arouse no suspicion of internal movement. And yet, when viewed with the aid of ingenious scientific instruments, the hard, fixed, continuous substance of the elements, dis-closes itself, under ultimate sub-division, to be a discontinuous conglomeration of numberless molecules and electrons, some of these latter superminute, almost dimensionless constituents moving in their orbits at a speed of 7000 million rounds in a millionth part of a second!

In this strange world wherein everything is moving, changing, rechanging, the strangest and most complex being of all, man, has been stretching forth his sense organs more than ever since he inherited his body from the ape-man and, as we have been told, has been working at Nature to fulfil his varied needs. In the process he has made great discoveries and laid the ancient foundations of science. He laid the foundations of mechanical engineering when to satisfy his need he was led to split the stone and manufacture the first implement. He laid the foundation of physics when again impelled by his need he was led to produce fire by rubbing one piece of wood against another. And so on and on from the Stone Age to the Atomic Age, it is one continuous story of man's efforts to gain and use knowledge and of the purpose of those efforts. The end of that story has not been reached. It can never be reached. Continuous movement; continuous adjustment, continuous aspiration, continuous achievement, is the law of action inherent in nature. We see it in the physical sphere, we see it in the mental sphere, we *should* see it also in the moral sphere.

Knowledge is one indivisible whole and yet the sciences are many. The blind men in the fable who feeling each with his hand a different limb of the elephant, could have only an imperfect conception of the animal. So we too, through detached contact with nature's manifold manifestations have built up the separate sciences of Astronomy, Mechanics, Physics, Chemistry, Biology, Botany, Zoology, Physiology, Psychology, Geology and numerous other more recent *logies*. It is wise to treat them as one whole, as nature seen from different angles, and yet the same nature. But though the instinctive motive and purpose which has led man to all these varied fields of research and study and to gain all this knowledge is the fulfilment of some need, the satisfaction of some urge that need and that urge may relate to the individual or it may relate to society.

As time has passed, as man has progressed, as the State has widened its activities, the social need has acquired the dominant role in shaping the direction of scientific research. The scientist is more and more in demand to help society out of its difficulties and to come to the rescue of nations suffering from social distempers. The scientist in our own country also has not to function in a vacuum. Nor has he to work in our laboratories in the pursuit of mere knowledge. India's laboratories have to hiss and fume against the background of a grim gaunt spectre of poverty and nakedness, ignorance and disease! That four-armed spectre stalks our land where man earns, on an average, less than two annas a day; where as many as 60 per cent of the people are underfed; where every fourth person gets annually devitalised by malaria; where the expectation of life is as low as 25 years, about half of what it is in the West; where nine out of every ten persons are sunk in illiteracy; where the overall annual consumption of cloth for the rich and the poor is a meagre 13 yds. per person; and where, above all, the cumulative impress of these deficiencies is tragically visible in those

features of national character which are pulling India back from its front place in all spheres of world activity.

The scientists of India have thus cut out for them a concrete and stupendous task. In collaboration with other comrades in the cause of all sided national reconstruction, they have to develop high speed of action if our masses have not to face cruel disappointment. The people cannot come into their own, the nation cannot rise to its full stature, India cannot pulsate with health and vigour, physical and mental, unless scientific research becomes not the specialised function of a handful of talented men in a few Universities, Hospitals, or Institutes, but the daily duty of thousands of our graduates working away at numerous well-equipped centres over a hundred and one urgent problems and sub-problems that confront one in every sphere of national reconstruction. A vast and rapid increase in facilities for research work is a most urgent need of the day in our country. More and more of our gifted youths and more and more of our national funds must be diverted to this end. We dare not lag behind the mass awakening. We dare not mark time when one crisis after another calls for big rapid strides on the path of reconstruction.

The German scientist I have quoted re-told us that the physical and intellectual wants of man were the starting point of our knowledge of things and natural phenomena. But are we also to end there? Must we not advance from the physical and intellectual wants to the wants of spirit? Can man only be a thinking animal? The law of evolution does not end with the body and the mind. It is a law of universal application. Everything changes, everything grows. And so also the moral side of man. Physical and intellectual progress unaccompanied by progress in the moral field spells grave danger to humanity. We have witnessed it, and we have regretted it each time foreign or civil war has shown up the brute in man. India too has had its warnings. She must not disregard them. We must re-establish the supremacy of the moral law and the use of moral means for all ends. A great teacher has been re-teaching us that great lesson. And so now, as in days of yore, let the study of the science of the spirit be the speciality of India, over and above the intensest study of all modern sciences and their application to the social and economic problems of the country.

A modern scientist has said:—

"The Universe is both larger and more complex than once appeared. We are not, as we thought, just about to understand it all. The larger the sphere of knowledge, the greater the era of contact with the unknown and the farther we push into the unknown, the less easy is it to represent what we find there in simple understandable terms."

Human personality, as Indians have reason to know, is a very complex phenomenon. Not all its aspects and powers have been discovered. Nor have all those that have been discovered received scientific exposition. India has traditions of some of the more mysterious aspects of this complex human personality. By some power not yet recognised by modern science, ancient seers of India calculated with unexcelled precision the movement of the stars. By an equally un-understood power, the great Bhrigu, a scientist of ancient India, worked out the minutest details of hundreds of successive lives of thousands of his contemporaries. India still has men who can by placing the fingers on the body know all the main incidents of a man's life history, who can by a similar touch see, as if under X-ray, the entire physiological processes of the body and affect them by sheer exercise of their own will. These and similar other phenomena are all by-products of the practice of *pranayam*, crudely translated as 'control of breath.' The science of Yoga has yet to be systematised. It has its physical as also its moral or spiritual aspects. My brief reference is only intended to indicate

that there are many mysterious aspects of human personality which, known to our ancestors, have to become afresh the subject of scientific research and the results so achieved made capable of propagation and application.

But these unknown aspects are not merely those designated as psychic. There are also others of a still higher order. They relate to the more fundamental verities of life. They mark out man for a nobler part in nature's mighty process of change and evolution. Their cultivation helps him to overstep all hurdles in life and to acquire the key to human happiness which remains the greatest and most basic urge of man. The great thinkers of ancient India made their instrumentless researches into the things of the spirit and discovered the solution of this eternal problem of human happiness. That solution is enshrined in the Gita, the Song Celestial. That brief epitome of all knowledge unfolds the secret of a happy and perfect life. It teaches that that secret is a certain attitude towards life. That attitude is one of ceaseless selfless righteous action without attachment to the fruit of such action. Day in, day out the sun radiates its heat, unworried whether all soils and men take its benefit or not. It spreads out its lustrous light, unworried who seeks to gain by it and who shuts himself against it. The wind blows all over the earth, unworried who endeavours to profit by it and who poisons it by misuse. The water runs down the river-bed, unworried who diverts it to rear life-giving crops and who lets it run unused to the sea. Nature, call it inanimate nature if you will, is teaching us everyday how to function in life and how, labouring for the well-being of all, in the midst of the intensest activity, to perform duty ceaselessly unaffected by the immediate result. If human evolution is to pass from the physical and the mental to the moral phase and if science and knowledge are still to fulfil the law of need and satisfaction in that domain, then, it must become the duty of special type of scientists to systematise the theory and practice of the Gita way of life. From the laboratory of the daily life and practice of those who have been adepts in this line must they rediscover to the modern world the true laws of a happy life, which is the ultimate unconscious urge for all human endeavour even when we merely plough the fields of physical science.

Let India's Universities and Academies of Science throw up again men in whom knowledge and action are reconciled and let India take up the lead again in systematising the moral sciences as of old. But let it not be misunderstood that India has to live in philosophical dreams away from the turgid currents of physical life. While in the midst of those currents, attacking and solving every problem that relates to the physical and mental aspects of human existence, shaping each day its externals more and more in accord with the needs of the moment, let India also acquire the only realistic and correct attitude towards human life and the universe, and towards their problems and their riddles. Let knowledge grow from more to more. Let its application to human life become more and more extensive. And yet let the mind be ever able to rise above failures and disappointments in our little plans of the day. Let Indian *savants* make their full contribution to the knowledge of the world and that contribution can never be complete if it merely follows the modern path leading to physical and mental satisfactions. A world thinker like Karl Marx, who interpreted thought and emotion and life and death in terms of dialectics, would not have broken down in the face of domestic bereavement or his own impending death, if the problems of life and their only abiding solution had been clear to him in all its full vividness. Let the Science of all sciences show us the true way of life. Let us be taught that science. Let India and you and I, its sons, by right endeavour in the fields of knowledge and action, deserve the rich heritage of immortal Janaka, who from this province of Bihar, taught humanity

how to live and labour, how to govern and serve, and how to die. May God give us the wisdom, the strength, the humility to accept that great heritage.

Sir C. V. Raman then read out certain portions from the written Presidential Addresses of Sir Ram Nath Chopra. Later, he delivered *extempore* his own address on "Chemistry and Physiology of smell", a subject in which he was interested and which he had taken up for spare time study.

Dr. B. Mukerji, Acting General Secretary, proposed a vote of thanks to His Excellency the Governor of Bihar and Patron of the Congress (Sri Jairamdas Daulatram), the Chairman of the Reception Committee and the Vice-Chancellor of the Patna University (Sir Chandeshwar Prasad Singh), the Local Secretaries (Dr. P. B. Ganguly and Dr. Basudeb Narayana) and the visiting foreign Scientists (Prof. A. Findlay of Great Britain, Prof. Shewhart of America, and the Australian Scientists led by Sir John Madsen). He paid glowing tribute to the help received from the University of Patna without which the function could not have achieved the success it had.

The inaugural meeting then concluded with a closing song sung by the girl students of the Patna University and the Medical College.

---

9. ANNUAL REPORT OF THE INDIAN SCIENCE CONGRESS ASSOCIATION 1947.

Introduction

In presenting the report for the year 1947, the Executive Committee wish to point out at the very outset that the year under review has been one of great stress for the Association. The recrudescene of communal trouble in Calcutta and the wave of political frenzy that swayed Bengal immediately before and following its partition and their repercussions on the day-to-day life of the province for some time completely paralysed the activities of the Association. The time of trouble synchronised with the period of maximum work of the Association and coupled with this, the postal irregularities which ensued, made the situation still worse. The work of the Association, as you are aware, is carried on largely through correspondence and any difficulty in the mailing system must naturally have direct effect on the work of the Association. Abstracts, Presidential Addresses, Discussions for symposia, etc. which should have been received by September, did not come at all to the office of the Association until about the middle of November and that too, after repeated telegrams and reminder letters were issued to the various Sectional officers. The facilities available in the Calcutta Presses were also considerably affected due to the opting out of a large number of skilled technicians, who were acquainted with the work of type-setting, etc., to Pakistan. At one time it appeared that the printing of the various materials needed for the Patna session could not be done. However, it is a pleasure to be able to report that through the enthusiastic and determined effort of the Acting General Secretary, Dr. B. Mukerji, it has been possible ultimately at least to discharge a part of the obligations of the Association towards their members. The Executive Committee hope that in view of the circumstances stated above, the members would be generous enough to condone the inconveniences that had occured to many of them and would also extend their full support to the Committee in their difficult task.

As in last year, the Indian Science Congress Association received recognition from many foreign scientific Associations. It will be recalled that several members and office bearers of the Association were invited by the Government of India as members of the Empire Scientific Delegation last year and they succeeded in establishing international

scientific collaboration not only with empire countries, but also with many European, American and Australian Societies. This has undoubtedly created a growing awareness of the value of Indian science in international spheres and as a result the ISCA received many enquiries this year from a large number of Scientific Bodies in America, Australia, Great Britain, Canada, Russia, etc. From countries such as Ceylon, Afganistan and Indo-China, several invitations and messages of goodwill were also received. Though in many cases, these invitations could not be honoured because of lack of funds and inability of the Assoc. to send out delegates to the places, reciprocity, through messages of goodwill and telegrams, were maintained with all these foreign bodies. It is a welcome sign that the ISCA is not only making its presence felt in scientific circles all over India but its work is being increasingly recognised outside the geographical borders of India.

Thirty-fourth Session: The thirty-fourth session of the I.S.C.A. was held at Delhi from January 2-8, 1947 under the auspices of the University of Delhi and was presided over by Pandit Jawharlal Nehru, Vice-President of the Interim Indian Government at the time. All the 13 Sections of the Congress had their separate sessions and the attendance of regular and sessional members was very satisfactory. In fact, an unprecedented enthusiasm was evinced at this session, partly because of the participation of Pandit Nehru and partly because of the presence of foreign scientists from Great Britain, America, Canada, China, France, Russia, etc. The General Committee met for 3 days and discussed several matters of importance regarding the general policy, administration and the lines along which the future activities of the Association should be canalised for the benefit of the country at large. A detailed report of this has been published as a separate leaflet which has been circulated to the ordinary members and is also being distributed from the office of the General Secretaries in the Congress enclosures.

Executive Committee

The Executive Committee (consisting of 17 members) which is entrusted with the transaction of all current business of the Association, met 8 times since the close of the last Delhi session on January 8, 1947. Most of the meetings were held in the headquarters at Calcutta. Of these, the meeting called on January 18, 1947 was an emergency meeting necessitated by the fact that Prof. P. C. Mahalanobis, the General Secretary in charge of the headquarters office, was invited to go to the United States as Chairman of the Statistical Commission of the U.N.O. and he proposed to leave India within a week. He requested the Executive Committee to make arrangements for the carrying on of the work of the Association during his absence. The Executive Committee decided that Prof. Mahalanobis be granted leave out of India and authorised him to contact foreign scientists during this period on behalf of the I.S.C.A. It was unanimously agreed that Dr. B. Mukerji, who carried on the work of the Association during the most pressing time last year and who was again returned to the Executive Committee by a large majority of votes, be entrusted with the duties of the General Secretary to the Association during the absence of Prof. P. C. Mahalanobis.

Of the members of the Executive Committee, Prof, P. C. Mahalanobis, Sir K. S. Krishnan and Prof. M. Qureshi were out of India on tour for different periods during the year.

Prof. M. Afzal Husain was elected Additional Vice-President and Prof. P. C. Mahalanobis Additional Member to the Council of the National Institute of Sciences of India as representatives of the I.S.C.A. for 1947. Dr. B. C. Guha who was elected representative of the I.S.C.A. on the Governing Body of the Indian Research Fund

Association last year continued to remain in office for the term of 3 years from September 1945.

The 'Central Advisory Board of Archaeology' under the Ministry of Education requested the I.S.C.A. to nominate a member to serve in their Advisory Board. Dr. N. P. Chakravorty, Jt. Director General of Archaeology, was nominated by the Executive Committee to serve in the Board as a member of the I.S.C.A. Dr. Chakravorty later wrote to say that he was already a member of the Board in his official capacity and requested the I.S.C.A. to nominate somebody else in his place. The Executive Committee thereafter nominated Prof. N. N. Chatterjee of the Geology Department of the Calcutta University to serve in the Board as a representative of the I.S.C.A. The 'Central Board of Irrigation' with the Government of India requested the Association to nominate a representative to serve in their Board. The Committee nominated Mr. P. C. Bose, Chief Engineer with the Government of West Bengal, to serve in the Board as a representative of the I.S.C.A. The Association was invited to be present at the Silver Jubilee Celebration of the Allahabad University and Dr. S. L. Hora attended the function as a representative of the Association and presented a message of goodwill to the University on behalf of the Association. The Roorkee College of Engineering invited the Association during their centenary celebrantions and Dr. S. Krishna and Prof. K. D. Bagchi were nominated by the Association to attend the function. The College of Technology, Benares Hindu University invited the Association to attend their silver jubilee function. A telegram was sent from the Association expressing good will of the I.S.C.A. The Cultural Adviser to the French Embassy in India requested the Association to establish relationship with the International Union for Biological Sciences. This was approved by the Executive Committee and necessary steps have been taken in this connection. The 'Ceylon Association for the Advancement of Science' requested the Association to send a representative at their annual meeting in December 1947. It was not possible to send a delegate form the I.S.C.A. but a telegram expressing good wishes and success to the Association was sent to them.

General Administration: Prof. P. C. Mahalanobis left India in the 3rd week of January to attend the Statistical Commission under the U.N.O. He returned to India in April 1947 and attended two meetings of the Executive Committee on 3rd April and 23rd May. The general work of the Association was however carried on all the time by Dr. B. Mukerji of the Central Drugs Laboratory, Government of India, Calcutta and a Member of the Executive Committee. While in India, Prof. Mahalanobis, with the permission of the Executive Committee, approached the Government of India again for a grant with the object of bringing out a foreign scientific delegation to the Patna session of the Congress. The Executive Committee decided that this time the personnel of the scientific delegation should be selected by a Committee consisting of two representatives of the ISCA, one representative of the National Institute of Sciences, one representative of the Inter University Board, one representative of the Council of Scientific and Industrial Research, one representative from the Ministry of Education and one representative of the External Affairs Department. This Committee was authorised to select individuals of the scientific delegation and intimate the names to Prof. Mahalanobis, who would simultaneously contact them and make arrangements for their visit to India to attend the Patna session.

Government of India Grant-in-aid: Since its inception in 1914, the ISCA has carried on its activities partly with the help, in the earlier years, of the Royal Asiatic Society of Bengal and mostly depending on its own membership subscriptions. No State help was forthcoming. In view of the steadily increasing expenditure of the Association

and in view of the fact that increase in the membership dues might result in discouraging the younger scientists from joining the Association, the Executive Committee decided to approach the Government of India for a grant of Rs. 25,000|- per year. In 1945-46, a sum of Rs. 5,000|- was sanctioned by the Government of India and again in 1946-47 the same amount had been sanctioned by the Government. The Executive Committee made a strong case for an increase of this grant to Rs. 25,000|-. In response to this urgent apatpeal, the Government of India have intimated the Association that they are considering the grant-in-aid of Rs. 15,000|- for the year 1947-48. This sum has not yet been sanctioned and the Association is approaching the Government for an increase of this grant to Rs. 25,000|-. If this grant is received, it would be possible to increase the much-needed clerical staff of the office, without which efficiency of the Association cannot be maintained. The Secretaries are honorary officers who have other duties to perform and it cannot be expected that they would be able to give very much time to the routine work of the Assoc. In spite of this it might be necessary to raise the subscription of members of the Association, which is considered very low in the light of the present high cost of printing and paper and the necessity for giving dearness allowance and interim relief pay to the employees of the Association.

Permanent housing of the Association and appointment of staff: The office of the Association was moved to the buildings of the Royal Asiatic Society of Bengal at No. 1, Park Street, Calcutta with effect from April, 1947. Some new furniture and Steel almirahs for the safe keeping of records were purchased. The space available for the use of the Association is not enough, and the General Secretaries have to bring most of the files to their own offices for disposal. This is unsatisfactory and leads to delay in the receipt and disposal of urgent communications. Efforts are being made to secure some space through informal discussions with the officers of the Royal Asiatic Society of Bengal.

Mr. B. L. Mukherjee, M.Sc., was appointed Assistant Secretary to the Association through advertisement and scrutiny of application by a Selection Committee consisting of Prof. S. K. Mitra, P. Ray, Dr. W. D. West and Dr. B. Mukerji. Mr. Mukherjee joined this appointment in August, 1947.

The need for an Accountant for the office of the Association is being keenly felt for sometime. This is an important requirement for any public body dealing with funds and membership subscriptions. If the increased grant from the Government of India is available, the post will be created in 1948.

Printing of the Proceedings: Part IV of the Proceedings of the Bangalore session of the Congress, 1946, could not issued in 1946. The arrear work was made up during the year and this volume distributed to all who were entitled by virtue of their membership to receive it. Due to the August disturbances of 1946, materials for the Delhi Session of the Congress had to be printed from presses outside Calcutta. All these materials had to be recomposed in Calcutta again for the printing of the Proceedings for the Delhi Session. Work in this connection had progressed to almost the final stages preparatory to the issue of the proceedings of the Delhi Session, when fresh troubles arose in Calcutta and the printing work for the Patna Session had to be given immediate priority. The result has been that the Proceedings of the Delhi Session have not yet been issued. It is to be hoped that conditions would enable the Executive Committee for 1948 to clear up all arrears of printing work. Shortage of paper was another serious difficulty which the Executive Committee for 1947 had to face. The Association consumes nearly 5 tons of paper every session. For 2 years, no paper quota had been applied for and received. At the request of the Executive Committee, the Acting

General Secretary proceeded to Delhi and succeeded in securing the necessary paper for the Association through the help of Hon'ble Dr. Shyamaprosad Mookerjee, without which no printing work for this work could be done for the Patna Session.

This year, Abstracts of papers are being issued in pamphlet form at the Venue of the Congress. As many Abstracts as were received in the office of the Association duly checked and approved by the respective Sectional Presidents up to December 10th, have been incorporated. Only a few Abstracts hav been left out. After the session is over, any further Abstracts that may be forwarded will be incorporated and the final volume (Part III of the Proceedings) will be issued early in March 1948.

Work of different Sub-Committees

(*i*) *Sub-Committee on Standard Time for India*: This Sub-Committee under the Chairmanship of Prof. S. K. Mitra submitted its report towards the end of 1946. It has since been printed in Part IV of the Proceedings of the Bangalore Session (33rd Session). Copies have also been circulated to the Railways and Airways authorities and to Government departments with a view to the uniform adoption of standard time all over India.

(*ii*) *Sub-Committee on the award of certificates to manufacturers of scientific apparatus*: Last year the Indian Science Congress Association set up a Sub-Committee to compile a report on the manufacture of scientific apparatus in India with a view to encourage plan, develop, advise and standardise their production as well as to give a fillip to this important line of manufacture. As Dr. B. Mukerji, the Convener of this Sub-Committee, had again to shoulder the burden of administration of the Association as the Acting General Secretary, he requested Dr. Johri of Dungar College, Ajmire, to take up the work and Dr. Johri drafted a letter and questionaire on the subject for circulation to the members and the Press. At about this time, the proposals regarding the establishment of an Indian Standards Institution under the Industries and Supply Ministry crystallized and it was felt by the Executive Committee that no useful purpose would be served at this stage by undertaking a scheme of enquiry which would most likely form one of the important functions of the proposed Indian Standards Institution. It was considered desirable to wait until 1948 and get in touch with the authorities of the Indian Standards Institution before proceeding further on this subject. If any Committee is being set up by the authorities of the Indian Standards Institutions, the Indian Science Congress Association should get a representation in this body and help in its work.

(*iii*) *Rules Revision Sub-Committee*: A circular letter dated the 19th June, 1946 was issued to all the members to send in their views and suggestions regarding the revision of the existing Rules and Regulations. Due probably to the disturbances in Calcutta and the general political interest all over India, satisfactory response was not received. The sub-committee had to be reconstituted during the year on account of the temporary absence of Prof. R. C. Majumdar and Dr. K. Biswas who were active members of the Committee. Prof. J. C. Sen Gupta has very kindly agreed to help the Association by making a critical preliminary survey of the Rules and the Executive Committee for 1947 would be glad if he is made the Convener of this Committee for the year 1948 and given full powers to coopt members for the smooth working of this Sub-Committee.

(*iv*) *Decimalization Sub-Committee*: A Bill for the decimalization of Indian Currency was introduced in the Legislative Assembly early in 1947. While this was a step in the right direction, the Indian Science Congress Association was of the opinion that the Bill did not go far enough and that Decimalization of weights

and measures, on the basis of the metric system, should also be considered simultaneously. With a view to create a strong public opinion in favour of this much-needed reform, a Sub-Committee with Mr. P. Sett of the Indian Decimal Society as Convener was appointed. This Sub-committee has kept up an energetic propaganda through the medium of the daily press and has also published 3 pamphlets outlining the advantages of the decimalization system. A small grant from the funds of the Indian Science Congress Association was made to defray the expenses incurred by the Sub-committee towards printing charges.

Shifting of the date of the Science Congress session

It will be recalled that the question of backdating of the Science Congress session from the first week of January to the third week of December (16|17th December), prior to the starting of the Christmas holidays, was taken up for consideration last year by the General Committee at Delhi. No definite decision could be arrived at. The general trend of discussion indicated that probably backdating would not be suitable and some University authorities, who were addressed on the question through circular letters in 1946, inclined to the view that no hostel accommodation for the visiting delegates could be provided in the third week of December when the students do not usually vacate their hostels. The question is for further discussion this year by the General Committee.

Renaming of the Engineering and Metallurgy section: The Executive Committee considered a proposal for the renaming of the Section of Engineering and Metallurgy so that the work of this section could be made more comprehensive and could embrace within its scope 'Industrial Research' of all descriptions. No definite decision could be arrived at and the subject is for further discussion by the Sectional Committee concerned, the Council, and later, the General Committee. The Executive Committee would abide by the majority decision in this regard.

Visit of Foreign scientists

Last year through the untiring efforts of Prof. P. C. Mahalanobis and Sir Shanti Swarup Bhatnagar, it was possible to bring out a representative delegation of foreign scientists to attend the Delhi session of the Congress. The scheme was a great success and the Delhi session last year could be considered as a milestone in the path of India's international cooperation in the field of science. The following foreign delegates from different countries attended:

(1) *Representing Royal Society of London*: (1) Sir Harold Spencer Jones, Astronomer, Royal Greenwich Observatory; (2) Prof. P. M. S. Blackett, Manchester University; (3) Sir D'Arcy Thompson, University of St. Andrews; (4) Prof. W. Brown, Botanist, Imperial College of Science & Technology; (5) Prof. L. J. Mordell, Mathematician, Cambridge University; (6) Dr. P. Bruce White, National Institute for Medical Research, London.

(2) *Representing British Association for the Advancement of Science*: (7) Sir Charles Darwin, National Physical Laboratory; (8) Sir Arthur Fleming, Great Britain; (9) Prof. H. Munro Fox, Zoologist, London University; (10) Prof. Dudley Stamp, Ministry of Agriculture, London.

(3) *Representing American Association for the Advancement of Science*: (11) Prof. A. F. Blakeslee, Botanist, Massachusetts; (12) Dr. W. E. Deming, Statistician, Washington.

(4) *Representing National Academy of Science of America*: (13) Dr. E. Newton Harvey, Zoologist, Princeton; (14) Oscar Riddle, Physiologist, Florida; (15) Dr. Harlow Shapley, Harvard Observatory.

(5) *Representing Royal Society of Canada*: (16) Dr. R. B. Thompson, Botanist, Toronto.

(6) *Representing National Research Council, Canada*: (17) Dr. R. W. Boyle, Electrical Engineer, Ottawa (18) Dr. W. F. Hanna, Plant Pathologist, Winnipeg; (19) Dr. T. L. Tandon, Geologist, Canada.

(7) *Representing French Academy*: (20) Prof. Jacques Hadamard, Mathematician, Paris.

(8) *Representing Chinese Academy of Science*: (21) Prof. S. S. Chern, Mathematician, Chungking.

(9) *Representing Soviet Academy of Science*: *U. S. S. R.* (22) Prof. V. P. Volgin, Moscow; (23) Prof. E. N. Pavlovsky, Tajikistan; (24) Prof. M. Umarov, Middle Asian University, U. S. S. R.

Advantage was taken of the presence of these foreign delegates to stimulate scientific activities in the various Indian Universities and Research Institutions. During the session, several symposia and popular lectures were arranged. Among those who gave *popular lectures* were Sir P. M. S. Blackett, Sir D'Arcy Thompson, Prof. Munro Fox, Sir Charles Darwin, Prof. Harlow Shapley, Sir Harold Spencer Jones, Prof. L. J. Mordell, Prof. Oscar Riddle, Prof. A. F. Blakeslee Prof. E. Newton Harvey, Prof. Volgin and Prof. Pavlovsky. Following the Delhi session, these delegates toured round the various universities and academic institutions in India and gave lectures and demonstrations.

The success of the scheme encouraged the Executive Committee to embark on a similar project this year also. At the April meeting of the Executive Committee, Prof. Mahalanobis, who returned to India at that time on a short visit, placed a fresh proposal for bringing out a representative body of scientists at the Patna meeting in January, 1948. The Executive committee having approved the proposal, the Government of India was again approached for a grant of Rs. 75,000|- as in last year towards the cost of travelling, etc., of the foreign delegates. The sanction of the Government of India was received on the 10th October and it was stipulated therein that the selection of scientific personnel for the delegation must be made through a 'Selection Committee'. Inspite of the best efforts of the office of the Association the final selection of Scientists could not be made before 22nd November, 1947. Invitations were immediately issued to the selected scientists by cable, air-mail letters and ordinary letters and also through the offices of the High Commissioner in London and through Indian Embassy in Washington. Soviet Academy of Science was also informed. The names of the Scientists selected are given below:

List No. 1. Physical Sciences, etc. Group.

1. Sir Robert Robinson, (Chemist), President, Royal Soc. London.
2. Sir Edward Appleton, (Physicist), England.
3. Dr. Sverre Petterssen, (Meteorologist), Norway.
4. Prof. Niels Bohr, (Atomic Physicist), Denmark.
5. Prof. A. Einstein, (Mathematician), Princeton, America.
6. Dr. H. Mark, (Physical Chemist), Brooklyn, America.
7. Dr. W. A. Shewhart, (Statistician), America.

8. Dr. Vannevar Bush, (Technologist), America.

Biological Sciences Group.

1. Prof. Szent-Gyorgyi, (Biochemist), Hungary.
2. Prof. C. H. Best (Physiologist), Canada.
3. Dr. George Strode (Medicine & Public Health Specialist). Rockefeller Foundation, New York, America.
4. Prof. J. H. Burn, (Pharmacologist), Oxford, England.
5. Prof. C. A. Elvehjem (Biochemist), Wisconsin, America.
6. Prof. D. Engelhardt, (Biologist), Russia.

List No. 2.

1. Prof. Roger Adams (Chemist), America.
2. Dr. Karl Meyer (Medicine), San Francisco, America.
3. Prof. A. Lawrence (Physical Chemist), America.
4. Prof. L. Negre (Tuberculosis specialist), France.
5. Prof. Lyle Cummins (Tuberculosis specialist), England.
6. Prof. Curio-Joliot (Atomic Physicist), France.
7. Prof. Hilditch (Chemist), England.
8. Prof. Kerst (Polymer Research Specialist), Illinois, America.
9. Prof. Edwar Bailey (Geologist), England.
10. Prof. C. E. Tilley, England.

Unfortunately due to delay in receipt of intimation regarding invitation most of the invitees could not manage to come out to India this time. Only Prof. Peterssen of Norway and Dr. Shewart of America could accept the invitation so far. Prof. Burn has written to say that the notice to vist India was so short that he would not be able to get away in time for the Patna Congress.

Last year, the Australian Scientists who were invited could not attend the Delhi Session and Prof. David Rivett, Chairman of the Australian Council for Scientific & Industrial Research promised to send an Australian Scientific Delegation in 1947-48. Through the invitation of the Government of India, a delegation of 5 Australian Scientists, Sir John Madsen, Sir Kerr Grant, J. A. Prescott, Mr. R. G. Thomas and Mr. G. B. Gresford are coming to the Patna Congress. These scientists will attend the session as distinguished guests of the Indian Science Congress Association.

Prof. Alexander Findlay, lately President of the Royal Institute of Chemistry of Great Britain and Ireland, is visiting India on a good-will mission on behalf of the Royal Institution of Chemistry. The Indian Science Congress Association has also extended a cordial invitation to him to be present at the Congress session and take part in the deliberation. Arrangements have also been made for his addressing some scientific associations and institutions in this country.

Council and Sectional Committee

The Indian Science Congress Association membership now stands at about 1200 general committee members (with voting rights), about 800 Sessional Members including Associate and Student members, on 15th December, 1947. About 500 full Sessional members are expected to enrol themselves immediately before and during the session at Patna. The total membership would thus approach a figure of 2,500, which can be considered to be the largest number of members affiliated to one single scientific organisation in India. If the activities of such an Association, which represents 13 different

scientific disciplines and under the auspices of which 22 learned Societies and Specialist Bodies hold their annual meetings and symposia, could be properly canalised and harnessed to the service of the nation, great benefit is likely to accrue both to science and the State. In a free country, 'science and the scientists' must come forward and take upon themselves the responsibilities of helping the State with their expert knowledge and technical abilities. The Council of the Indian Science Congress Association represents all the scientific intelligentia of the country and it is proposed to convene a special meeting in 1948 to consider the ways and means of improving the work of the Association and bring this body to the level of such organizations as the British and American Associations for the Advancement of Science. The funds at the disposal of the parent body had not been sufficient to enable the Indian Science Congress Association to expand its activities in the way that it would have liked. A proposal for increasing the membership free from Rs. 12|- to Rs. 15|- is being forwarded for the consideration of the Council. This, supplemented with an increased grant from the Central Government, would enable the Association to bring in various schemes of development in the year 1948.

One of the important things to be considered is the arrangements that should be made towards the development of international contacts between Indian Science and World science. As a direct result of the foreign scientific delegations visiting India last year and the frequent tours of leading Indian Scientists to Great Britain, Europe and America, a world brotherhood of scientists is being established in which India is being asked to participate in increasing degrees. To enable this type of scientific fellowship to be maintained, it is proposed to create, if the Council and the General Committee approve, the post of a 'Foreign Secretary' in the Indian Science Congress Associations with the following functions:

(*a*) To effect co-ordination between scientific academies, societies, institutions and Government scientific departments and services outside India.

(*b*) To represent internationally the scientific work in India, when called upon by the Executive Committee to do so, outside India.

(*c*) To conduct correspondence with foreign countries relating to the business of the I.S.C.A., to return thanks for presents from foreigners made to the Association, and to forward to persons elected Honorary Members the Diplomas certifying their elections to the Association.

(*d*) To do and perform all other acts, matters and things that may assist in, conduce to or be necessary for the fulfilment of the above mentioned aims of the Association.

The 'Sectional Committees,' unfortunately have not functioned as well as could be expected. Last year, requests were made to these bodies to prepare 'reviews' of *outstanding results* achieved in various sciences during the year as a result of new contributions by Indian and foreign scientists. Only a meagre effort was made by the Agriculture Section in this direction last year and this year nothing worthy of record was produced. The general disturbances in the whole country during this eventful year, 1947, must have been responsible for this. It is hoped that a better account can be given next year. It is proposed to issue regular reminders from the Headquarters office to the Sectional officers, otherwise a state of hibernation apparently sets in.

General Committee

The Executive Committee would like to receive suggestions *in writing* from the members themselves for improving the work of the Association. The outgoing committee realise that much that could have been accomplished in 1947 has been left undone

and they wish to place on record their regret for not being able to discharge in a fuller measure the responsibilities thrown on their shoulders by the general body of members. They however wish to emphasise that no efforts were spared on their part in giving a good account of themselves during the year of their trusteeship of the Association. Often the circumstances went beyond their control. Next year the conditions would be expected to settle down in Calcutta, the headquarters of the Association, and also in the rest of geographical India, and scientific activities could be organised on a high level of efficiency.

A suggestion which the outgoing Executive Committee would like to make to the General body of members is to help the Association through personal influence, to enlist more 'Ordinary Members,' so that their active interest could be focussed throughout the year on the activities of the Association. In most cases, scientists get themselves enlisted at the last minute and a large shifting, fluid membership of the Association is thus created which does not add to the strength of the organisation. Below is given, in tabular form, a zonal distribution of 'Ordinary Members' as on November 1st., 1947. Obviously there is need for further strengthening of the influence of the Association in Southern, Western, Central and North Western Zones, and the cooperation of all regular Members is sought in this direction.

Full Members (with voting rights)—1060

			Percentage.
Eastern Zone			
	Calcutta	290	
	Bengal	29	
	East Bengal	17	
	Bihar	113	
	Assam	12	
	Orissa	6	
		467	44.05
South Zone			
	Madras	92	
	Hyderabad (Deccan)	26	
	Mysore	42	
	Travancore	13	
		173	16.30
Western Zone			
	Central Province	23	
	Bombay	137	
		160	15.09
Central Zone			
	U. P.	129	
	Raj.	10	
	C. I.	10	
		149	14.05

North Western Zone

Punjab	34	
Delhi	66	
N. W. F. P.	1	
Sind	5	
	160	10.00
Foreign	5	0.005
Total ..	1060	99.5 % (Approx.)

Changes in Rules: Last year a proposal for amending Rules 23 and 25 of the Association was circulated and discussed at the third meeting of the General Committee in the pandal at Delhi. It was decided that Calcutta would continue to remain the Headquarters of the Association. Regarding the term of Office of the General Secretaries (Rule 25), the discussion that arose did not result in any final decision. This amendment is being placed again before the Council and the General Committee this year.

Association of Scientific Workers of India: On a motion before the General Committee by Prof. B. C. Guha, an Association for Scientific Workers in India was inaugurated under the auspices of the Indian Science Congress Association at the second meeting of the General Committee under the presidentship of Pandit Jawharlal Nehru. A provisional Committee was set up to draft a constitution for this body which will be placed for finalisation before the Patna Science Congress.

Budget and Accounts: The Budget estimates for the year 1947-48 and audited statement of receipts and payments for the year 1946-47 are given in the end, for the information of members. For comparison, the accounts of the previous year are also given side by side. It will be seen that the expenditure of the Association has increased considerably. This is only to be expected from an all round increase in staff salaries, dearness allowances, interim relief pays, cost of paper, printing charges, etc. The case for an increase in membership subscription is therefore clear and in the interest of continuity of work of the Science Congress, the members are requested to give their serious consideration to the proposal of increase of subscription which is being put forward.

Submitted on behalf of the Executive Committee (1947-48).

Calcutta.

15th December, 1947.

B. Mukerji

M. Qureshi (*in absentia*)
General Secretaries.

10. MEETING OF COMMITTEE

GENERAL COMMITTEE: JANUARY 5, 1948.

A meeting of the General Committee of the Indian Science Congress Association was held at the Physics Lecture Theatre, Science College, Patna, at 2-30 P.M. on Monday January 5, 1948. As the Acting General President, Sir C. V. Raman, was otherwise busy at the time, Dr. S. L. Hora was voted to the chair. At a later stage, Sir C. V. Raman attended the meeting.

Mr. G. V. Asolkar, Dr. K. N. Bagchi, Mr. P. C. Bandyapadhyay, Mr. B. Banerjee, Dr. S. Banerjee, Mr. S. S. Banerjee, Dr. C. Barat, Dr. B. C. Basu, Mr. N. M. Basu, Dr. R. N. Basu, Dr. U. P. Basu, Dr. G. D. Bhalerao, Mr. P. M. Bhargava, Mr. H. P, Bhaumik, Dr. P. C. Biswas, Mr. A. K. Bose, Mr. A. N. Bose, Mrs. Chameli Bose, Dr. J. K. Bose, Dr. P. K. Bose, Mr. M. C. Chakrabarti, Mr. N. M. Chakrabarty, Mr. S. V. Chandrasekhar Aiya, Mr. V. R. Chariar, Dr. M. L. Chatterjee, Mr. S. C. Chatterjee, Dr. S. K. Chatterjee, Mr. T. D. Chatterjee, Mrs. Bani Chatterji, Mr. N. Chatterji, Dr. B. S. Chauhan, Dr. G. W. Chiplonkar, Mr. A. C. Chowdhury, Miss Latika M. Dalal, Mr. J. Datt, Mr. S. Deb, Mr. T. K. Deolalkar, Dr. S. V. Desai, Dr. A. N. Dhar, Mr. K. R. Dixit, Dr. K. S. G. Doss, Dr. A. K. Dutta, Mr. Ajit Kumar Dutta, Mr. S. A. Faseeh, Mr. D. Ganguly, Mr. P. J. Ghadialy, Mr. A. K. Ghosh, Mr. B. N. Ghosh, Mr. N. C. Ghosh, Mr. N. L. Ghosh, Dr. P. K. Ghosh, Mr. S. M. Ghosh, Mr. P. W, Gideon, Mr. A. Gopala Krishna, Dr. S. D. S. Greval, Dr. B. C. Guha, Dr. S. S. Guha Sarkar, Mr. S. Gupta, Dr. S. L. Hora, Mr. L. A. N. Iyer, Dr. G. V. Jadhav, Mr. S. Jalota, Dr. S. K. K. Jatkar, Mr. S. Jones, Dr. A. C. Joshi, Dr. A. N. Kappanna, Mr. S. M. Kerawala, Dr. S. R. Khastgir, Dr. D. S. Kothari, Mr. Y. N. Kotwal, Mr. P. G. Krishna, Dr. G. P. Majumdar, Mr. D. R. Malhotra, Mr. G. D. Mathur, Dr. K. C. Mazumdar, Mr. J. N. Mehta, Dr. A. B. Misra, Mr. R. C. Misra, Dr. H. K. Mitra, Dr. M. A. Moght, Dr. H. K. Mookerjee, Mr. S. Mookerjee, Dr. B. Mukerji, Mr. D. Mukerji, Mr. S. N. Mukherjee, Dr. D. N. Mullick, Dr. G. V. L. N. Murty, Mr. T. N, Muthuswami, Mr. H. K. Nandi, Dr. M. C. Nath, Dr. B. S. Navalkar, Dr. P. Neogi, Dr. N. Kesava Panikkar, Dr. M. S. Patel, Mr. Prem Prakash, Dr. B. N. Prasad (Allahabad), Dr. B. N. Prasad (Patna), Mr. D. V. Rajalakshman, Sir C. V. Raman, Dr. B. Sonjiva Rao, Mr. M. Umanath Rao, Dr. J. C. Ray, Mr. P. Ray, Dr. Ro Co Ray, Dr. R. H. Richharia, Dr. Ko P. Rode, Mr. S. N. Roy, Mr. S. P. Roy, Mr. T. C. Roychowdhuri, Mr. J. N. Rudra, Mr. M. N. Rudra, Mr. N. K. Saha, Dr. P. C. Sarbadhikari, Dr. B. B. Sarkar, Mr. B. K. Sarkar, Dr. P. B. Sarkar, Mr. S. S. Sarkar, Mr. N. S. R. Sastri, Mr. M. L. Schroff, Mr. A. C. Sen, Mr. B. B. Sen, Mr. K. B. Sen, Mr. N. Sen, Mr. S. K. Sen, Dr. J. C. Sengupta, Mr. M. Sengupta, Dr. S. R. Sengupta, Dr. T. R. Seshadri, Dr. B. R. Seth, Mr. S. M. Sethna, Dr. C. C. Shah, Dr. M' L. Shah, Mr. N. L. Sharma, Mr. G. S. Sidhu, Dr. M. B. Soparkar, Dr. B. Sundra Raj, Mr. S. Swaroop, Dr. N. R. Tawde, Mr. V. M. Thakar, Mr. N. K. Tiwary, Mr. P. S. Varma, Dr. Lal. C. Verman, Dr. B. P. Yadava and others were present.

1. *Appointment of Dr. B. Mukerji as General Secretary.* At the outset, the President Dr. S. L. Hora announced that Prof. P. C. Mahalanobis has tendered his resignation as General Secretary, on account of the fact that he had again been requested to come to America for sometime. The Executive Committee therefore had no other way but to accept his resignation and nominated Dr. B. Mukerji, acting General Secretary to fill up the vacancy caused. It is now for the House to express their opinion on the nomination of the Executive Committee.

The nomination of Dr. B. Mukerji was unanimously approved by the General Committee.

2. *Minutes dated 4th, 6th and 7th January, 1947 Confirmed.* The minutes of the proceedings of the last meetings of the General Committee held on 4th, 6th and 7th January, 1947 (circulated) were taken up for consideration. There were no objections and the minutes were taken as confirmed.

3. *Annual Report of the Executive Committee, Statement of Accounts for the year ending 30th November, 1947 and Budget estimates for the year 1947-48 (circulated) were adopted.* Dr. B. Mukerji (General Secretary) placed before the meeting the Annual Report, Statement of Accounts and the Budget estimates. There was some discussion on the Budget estimates in which several members took part but ultimately no specific objection was raised. Dr. S. P. Agharkar suggested that Assets and Liabilities should be shown separately when presenting the Budget estimate. Dr. S. P. Agharkar also remarked that Annual Report should first be placed before the Council for its adoption and then before the General Committee for its final approval.

At this stage Dr. A. C. Ukil proposed and Dr. B. N. Prasad seconded that the Annual Report, Statement of Accounts and Budget estimates be adopted.

4. *Ways and means of improving work and the question of increase in the rate of membership subscription from Rs. 12|- to Rs. 15|-.* There was a general discussion in regard to the enhancement of membership subscription. Some members felt that the proposed enhancement was justified because the cost of printing and paper has since increased significally. But the majority was in favour of deferring the matter for the present. At this stage, the Chairman Dr. S. L. Hora reported that the question of increase in the rate of membership subscription had been referred to a committee for examination and its report would be placed before the next meeting of the General Committee for consideration. This action was approved by the House.

Amendment to Rule 25. Amendment which was proposed on Rule 25 and brought forward in 1947 session was then taken up for consideration. The proposed changes are indicated below:

Present Rule.

25. The term of office of each General Secretary and of the Treasurer shall be for a period of *five years* following the confirmation of the appointment by the General Committee. They shall not be eligible for re-election to the office for a period of three years after the termination of their appointment.

Amended Rule.

The term of office of each General Secretary and of the Treasurer shall be for a period of *three years* following the confirmation of the appointment by the General Committee. They shall not be eligible for re-election to the office for a period of three years after the termination of their appointment.

There was a general discussion in which Drs. S. P. Agharkar, B. N. Prasad, A. C, Ukil, Prof. J. M. Sen and others participated. The amenedment to Rule 25 was then put to vote and passed by a large majority.

6. *Announcement of elections to the Executive Committee and the Council.* Dr. B. Mukerji (General Secretary) reported the following results of the election of members to the Executive Committee and to the Council for the year 1948-49.

Executive Committee. 1. Prof. K. N. Bahl. 2. Prof. G. P. Mazumdar. 3. Prof. A. C. Ukil. 4. Dr. K. Venkataraman. 5. Dr. K. N. Bagchi. 6. Dr. W, D, West,

7. Dr. Baini Prasad. 8. Prof. B. Sanjiva Rao. B. C. Guha, and 10. Dr. U. P. Basu.

Council. 1. Dr. H. J. Bhabha. 2. Dr. G. D. Bhalerao. 3. Dr. B. C, Basu, 4. Dr. Basudeb Banerjee. 5. Dr. B. N. Prasad. 6. Dr. C. Barat and 7. Capt. R. N. Basu.

7. *Announcement of the name of the General President for the 1949 session.* Dr. B. Mukerji (General Secretary) announced that the Executive Committee had recommended the election of Sir K. S. Krishnan, F. R. S., as General President foi the 1949 session. The proposal was confirmed by acclamation.

8. *Announcement of the names of Sectional Presidents and Recorders for 1949 session.* The Chairman Dr. S. L. Hora announced the names of Sectional Presidents and Recorders for 1949, as follows:—

Section	*President*	*Recorder*
1. *Mathematics* ..	Prof. S. Chowla	Prof. P. N. Das Gupta
2. *Statistics*	Dr. U. S. Nair	Shree Sadashiv Sen Gupta
3. *Physics*	Dr. R. S. Krishnan	Dr. P. S. Gill
4. *Chemistry* ..	Dr. P. B. Ganguly	Dr. Dukhaharan Chakravarti
5. *Geology & Geography*	Dr. C. Mahadevan	Dr. S. C. Chatterjee
6. *Botany*	Mr. M. S. Randhwa	Dr. R. L. Nirula
7. *Zoology & Entomology*	Dr. M. L. Roonwal	Dr. H. D. Srivastava
8. *Anthropology & Archaeology*	Mr. Nirmal Kumar Bose	Mr. M. N. Basu
9. *Medical & Veterinary Sciences* ..	Dr. M. B. Soparkar	Dr. Harendranath Ray
10. *Agricultural Sciences* ..	Dr. R. S. Vasudeva	Mr. P. C. Raheja
11. *Physiology* ..	Dr. B. B. Sarkar	Prof. N. P. Banwari
12. *Psychology & Educational Science* ..	Mr. T. K. N. Menon	Prof. Kali Prasad
13. *Engineering & Metallurgy*	Prof. M. Sen Gupta	Mr. J. Ganguly

9. *Venue of the next annual session.* The Chairman announced that invitation to hold the next session of the Congress had been received from Allahabad and also from Poona. It should be recalled that the Allahabad University had also previously requested the Indian Science Congress Association to hold its present session there but at Delhi session preference was given to Patna. It was therefore considered desirable that the invitation from the Allahabad University should be accepted. There was some discussion in which Dr. S. P. Agharkar, Dr. P. Neogi and others participated. The majority opinion however favoured Allahabad and therefore the proposal for having the session at Allahabad in 1949 was confirmed.

10. *Election of two members to each of 13 Sectional Committees.* The General Committee then proceeded to the elections of members to each of the 13 Sectional Committees. After the names were proposed and seconded the following elections were made by majority of votes:

Mathematics	Dr. Nalini Mohan Basu and Dr. B. R. Seth
Statistics	Mrs. Chameli Bose and Dr. P. V. Sukhatme
Physics	Mr. N. K. Saha and R. N. Rai

Chemistry	Mr. S. Roy and Dr. N. N. Ghatak
Geology and Geography ..	Dr. S. Deb and Mr. K. Bagchi
Botany	Dr. B. K. Kar and Dr. P. Maheswari
Zoology & Entomology ..	Dr. S. M. Ghosh and Dr. B. C. Basu
Anthropology & Archaeology ..	Mr. Satyendra Prasad Roy and Mr. Anil Chowdhury
Medical & Veterinary Sciences ..	Dr. A. K. Bose and Dr. J. C. Ray
Agricultural Sciences	Dr. J. S. Patel and Dr. S. C. Roy
Physiology	Dr. Sachchidananda Banerjee and Dr. S. K. Sen
Psychology & Educational Science	Mrs. R. C. Chowdhury & Mrs. S. K. Chatterjee
Engineering & Metallurgy ..	Mr. J. Datta and Mr. D. R. Malhotra

VOTE OF THANKS

Dr. S. L. Hora proposed from the Chair a Vote of Thanks to H. E. the Governor of Bihar for consenting to be the Patron of the Association for the Session at Patna and opening the Session (*carried unanimously*).

Dr. S. L. Hora proposed from the Chair a vote of thanks to the Vice-Chancellor of the Patna University for his kind invitation to hold the session under the auspices of the Patna University (*carried unanimously*).

Dr. B. Mukerji (General Secretary) proposed a vote of thanks to Sir C. V. Raman, for his having kindly presided over the Session in the absence of the President-elect Sir Ram Nath Chopra at short notice (*carried unanimously*).

Dr. B. Mukerji (General Secretary) proposed a vote of thanks to the Chairman and the members of the Local Committee for the splendid arrangements made for the Session (*carried unanimously*).

Dr. B. Mukerji proposed a vote of thanks to the Local Secretaries for all the local arrangements and to volunteers for their help in organising such a big session (*carried unanimously*).

Dr. A. C. Ukil proposed a vote of thanks to Dr. B. Mukerji for his agreeing to shoulder the responsible work of the Association as its Acting General Secretary during the absence of Prof. P. C. Mahalanobis for the major part of the past year (*carried unanimously*).

Dr. A. C. Ukil proposed a vote of thanks to Prof. P. Ray, Treasurer, for his services during the past year (*carried unanimously*).

COUNCIL MEETING

A meeting of the Council of the Indian Science Congress Association was held at the University Buildings, Administrative Block, Patna on Thursday the 1st January 1948 at 3-30 P.M. As the President (Sir C. V. Raman) was busy in connection with other work, Prof. M. N. Saha took the chair.

The following Members were present: Prof. M. N. Saha, Dr. B. Mukerji, Dr. J. N. Mukherjee, Prof. P. C. Mahalanobis, Dr. A. C. Ukil, Dr. U. P. Basu, Prof. P. Ray, Prof. S. P. Agharkar, Dr. B. B. Sarker, Prof. B. Sanjiva Rao, Dr. B. C. Kundu, Dr. B. Narayana, Dr. P. B. Ganguly, Prof. M. Sen Gupta, Dr. B. N. Prasad, Prof. A. B. Misra, Rai Bahadur Kalidas Sawhney, Dr. G. D. Bhalerao, Dr. M. A. Moghe.

PROCEEDINGS

1. The minutes of the meeting held on 1st January 1947 at the University Buildings, Delhi, (circulated) were confirmed.

2. *General Discussion on the ways and means of improving the work of the Association.* After the President opened the discussion with a brief account of the progress of the Association for the last 34 years, a brisk discussion on this item took place. He stated that starting from a very small beginning, the Association has steadily gained importance and can now be considered as the largest scientific organisation in India. Science is going to play more and more important part in the life of all individuals of independent India and the time has now come when ways and means for improving the work of this body and bringing its message to the doors of all scientific workers in India should be considered seriously. With the initiation of the programme of the annual visits of the foreign scientists to the session of the Science Congress, the scope and responsibility of the organisation have further increased during recent years. As the Council of the I. S. C. A. represents all the foremost scientists of the country, he requested that they should give a little thought to this matter and send their considered suggestions in writing to the Secretary.

Prof. J. N. Mukherjee, ex-Secretary and Treasurer of the Association, suggested that a Sub-committee should be set up consisting of the ex-Treasurers and ex-Secretaries and the present officers of the Association to go more deeply into this question. He pointed out that the cost of printing the Proceedings is gradually increasing and is likely to be even more in the years to come. It would therefore be necessary to drastically cut down the number of Abstracts presented in each Section. He said that it was his experience that many Abstracts were received without their full papers and many scientists submit 'Abstracts' to the ISCA with a view to getting permission from their respective Governments and University authorities to attend the session. In many cases, he pointed out, it was his experience, that several scientists never completed the work which they presented in the form of Abstracts at the Congress Session. He emphasised the need of very careful scrutiny on the quality of Abstracts before these are permitted to be printed and in no case, these should be printed unless and until they are accompanied by the full papers. This step, he said, would reduce the number of Abstracts and limit it to only the better types of research notes, thereby reducing the cost of production of the Proceedings.

Dr. B. N. Prasad, Dr. A. C. Ukil, Prof. S. P. Agharkar and others joined in the discussion. Various suggestions were made but no clear-cut line of action could be formulated. In view of the importance of the subject, it was decided that another meeting of the Council should be convened for a fuller discussion of the topic. The Secretary was asked to issue notices immediately and if necessary the meeting could be held in the evening at the general 'pandal', immediately preceeding or following a popular lecture' scheduled to be held in the evenings.

The meeting terminated with a vote of thanks to the chair.

ADJOURNED COUNCIL MEETING

The adjourned meeting of the Council was held in the pandal at the University College grounds on 3rd January 1948 at 7-30 P.M. Prof. S. P. Agharkar took the chair.

The following members were present:—Dr. S. L. Hora, Prof. P. Ray, Dr. U. P. Basu, Dr. B. Mukerji, Mr. A. Chatterjee, Dr. P. K. Ghosh, Dr. Vaidyanathaswamy, Dr. M. A. Moghe, Dr. B. C. Kundu, Mr. N. Sen, Mr. A. Chatterjee, Dr. B. N, Prasad, Dr. A. C. Ukil, Prof. M. Sen Gupta, Prof. B. B. Sarker.

PROCEEDINGS

1. The general discussion on the ways and means for the improvement of the work of the Association, which was left over on 1st January, was resumed. Prof. Agharkar from the chair supported the proposal of Prof. J. N. Mukherjee made in the first meeting of the Council that a Committee should be set up with all past Presidents, Secretaries and Treasurers of the ISCA to go into this question. He said that most of the officers would be coming to Calcutta in March in connection with the meeting of the National Institute of Sciences of India. If the General Secretary could get together all the relevant suggestions at that time, it might be possible for them to meet in Calcutta and discuss them and finalise any concrete suggestions that might be forthcoming in the meantime from the Council members. It would also be necessary to have the accounts of the Association brought up to date before the meeting in March.

Dr. B. Mukerji, General Secretary, stated that the interval between the termination of the Patna Session and the March meeting of the National Institute of Sciences at Calcutta is too short to get all the accounts, etc., ready for a meeting of the council at Calcutta, but he will make every effort to get the necessary materials ready by that time.

2. *Consideration regarding the need for increasing the Membership fee of the Association.* Dr. B. Mukerji stated that the Membership of the Association now stands at about 1200 Ordinary Members and about 800 Sessional Members, including Associate and Student Members. The cost of supplying 4 parts of the Proceedings to the Ordinary Members and Full Session Members is gradually rising and last year it had been extremely difficult to secure paper. The funds at the disposal of the Association had never been sufficient to eanble this body to expand its activities in the way that it should have done. The responsibilities that lie on the largest scientific Association in India is of such magnitude that no further time should be lost in increasing the Membership of the Association and also raising the Membership fee from Rs. 12|- to Rs. 15|-. The increase of Membership will naturally raise the status of the body and strengthen its influence all over India, but at the same time it would involve additional expenditure in connection with the distribution of the Proceedings to the Members. A rough calculation of the cost of production at present appears to indicate that the printed material supplied to each Full Member costs the Association more than the amount it draws from a Member as his individual Membership fee. But for the grant received from the Government and other endowments, it would not be possible for the Association to maintain this stndard for many more years to come. The Government of India have already been approached for an increased yearly grant. Even if this is granted, this must be supplemented with increased revenue which the Association should draw from its Membership fees.

Prof. Agharkar stated that the increased Membership fee should not be agreed to without going more deeply into the question, as one of the primary purpose of the ISCA is to bring the message of science to the doors of the poorest scientific workers. In view of the increased cost of living and in view of the fact that scientific workers in India are not treated very well financially, the raising of the Membership fee may mean the drifting away of a large number of junior Members, which would ultimately affect the scientific potential of the country.

Dr. Hora supported Dr. Mukerji in the statement that the actual cost of printing 4 volumes of the Proceedings and the correspondence and postage, etc. involved in keeping contact with individual members in these days would exceed the membership fees realised from individual members. Addition of members therefore would be more a

liability than an asset to the association, as far as the financial side in concerned. Dr. B. N. Prasad was in favour of increasing the revenue of the Association through special approaches made to the Provincial Governments' the Central Government and the Universities. After these avenues are tapped and adequate response is found to be lacking, only then the proposal of Dr. Mukerji for an increase of the Membership fee should be agreed to. It was decided that the General Secretary be requested to enter into correspondence with the various bodies with a view to getting grants for the ISCA and report on the response received at a future meeting of the Council, if it could be arranged during the year 1948.

3. *Consideration of the recommendation of the Executive Committee to create a new post of Foreign Secretary.* Dr. B. Mukerji stated that in view of the fact that more international contacts have to be developed between Indian science and world science, it seems desirable that the post of a Foreign Secretary to the ISCA be created with the following functions:

(*a*) To effect co-ordination between scientific academies, societies, institutions and Government scientific departments and services outside India.

(*b*) To represent internationally the scientific work in India, when called upon by the Executive Committee to do so, outside India.

(*c*) To conduct correspondence with foreign countries relating to the business of the ISCA, to return thanks for presents from foreigners made to the Association, and to forward to persons elected Honorary Members the Diplomas certifying their elections to the Association.

(*d*) To do and perform all other acts, matters and things that may assist in, conduce to or be necessary for the fulfilment of the above mentioned aims of the Association.

Dr. A. C. Ukil, Prof. P. Ray, Dr. U. P. Basu, and Dr. K. Sawhney supported the proposal.

Prof. Agharkar from the chair said that the National Institute of Sciences of India has already been recognised by the Government of India as the consulting scientific body and this body has a 'Foreign Secretary' who keeps contact with all foreign scientific organisations on behalf of the Government of India and Indian scientists. It would not be proper therefore to create another parallel post of this type, which will lead ultimately to strained relations between sister scientific organisations in India. Moreover, he pointed out, the functions suggested for this post are more or less the same as the functions of the Foreign Secretary of the NISI. After some discussion, in which Dr. Sanjiva Rao, Dr. B. C. Kundu, Dr. G. D. Valerao, Dr. Moghe and Dr. Prasad joined, it was ultimately decided to drop the idea for the present.

The meeting terminated with a vote of thanks to the chair.

EXECUTIVE COMMITTEE

Ten meetings of the Executive Committee were held during the year 1947-48. The Annual Report published earlier gives the important items of business transacted excepting those done at the meetings held at Patna. Most of the business done at these meetings have been reported to the General Committee.

SUB-COMMITTEE ON SCIENCE AND ITS SOCIAL RELATIONS

A meeting of the Sub-Committee was held at 11 A.M. at Patna on the 2nd January, 1948.

Part I: Official Matters

Members Present: Prof. M. N. Saha (in the chair), Mr. J. M. Sen (Cal.), Dr. H. K. Mitra (Jamshedpur), Prof. D. D. Kanga (Adyar), Dr. G. D. Bhalerao (President, Med. & Vet. Section, Izatnagar), Dr. K. Sawhney (President, Agricultural Science, Hyderabad), and Dr. A. C. Ukil (Convener, Calcutta).

1. The minutes of the meeting held on 25. 6. 47, which had previously been circulated, were confirmed.

2. The Annual Report for 1947, which was circulated to the members present, was read and adopted.

3. With regard to the future plan of work, the following proposals were accepted and recommended to the Executive Committee for necessary implementation:

(*a*) With regard to the study of Sociology in Indian Universities, it was decided, to request the Universities to have a chair of Sociology, with a well thought-out curriculum to suit Indian requirements. Prof. Benoy Kumar Sarkar was requested to suggest a tentative curriculum for consideration of the Sub-Committee. In this connection, it was resolved to request the Executive Committee to invite a distinguished Professor of Sociology from an American or British University as a delegate to the next session of the Indian Science Congress and to request him to advise some of the Universities in India on the establishment of a Department of Sociology, the respective Universities contributing towards the expenses of his stay.

(*b*) to request the Directors of Agriculture of provinces and the Universities who have a Degree course in Agriculture to include the subject of Rural Sociology in the Degree course in Agriculture.

(*c*) to write to Prof. Joseph Needham of the UNESCO to indicate how best the Indian Science Congress Association, through its Sub-Committee on Science and its Social Relations, could co-operate with the UNESCO. As "Science & Culture" takes a good deal of interest in emphasizing the social functions of science, it was decided to request the Executive Committee to approach the UNESCO for some financial assistance to intensify its efforts in this direction.

(*d*) to make arrangements for the publication of popular articles in Science & Culture and other suitable periodicals.

(*ii*) The members of the Sub-committee were requested to continue to contribute popular articles on the social utilization of science and how to remove the lag between science and its applications in India.

4. It was decided to present the following Resolution before the meeting of the General Committee to be held at the Patna Session:—

In view of the fact that the study of Social Sciences has assumed an added importance in free India and in order to enlarge the scope of Psychology by incorporating Sociology into it,

Be it resolved that the section of "Psychology and Educational Sciences" be hereafter named the section of "Psychology, Educational and Social Sciences."

5. The subject for the next year's symposium was decided to be left to the Sub-Committee.

6. The Sub-Committee recommended the following members to constitute the Sub-Committee for the ensuing 12 months.

(*a*) 4 representatives of the Executive Committee, *viz.*, the General President, the 2 General Secretaries and the Treasurer, ex-officio;

(*b*) Presidents of the 13 sections of the Indian Science Congress, ex-officio; and
(*c*) The following members of the Indian Science Congress Association: Dr. Gilbert J. Fowler (Bangalore), Prof. D. D. Kanga (Adyar), Dr. K. Motwani (Adyar), Prof. H. P. Maiti (Patna), Prof. M. N. Saha (Calcutta), Sir Sahib Singh Sokhey (Bombay), Mr. D. N. Wadia (Delhi), Prof. H. J. Bhabha (Bombay), Prof. Benoy Kumar Sarkar (Calcutta), Dr. H. K. Mitra (Jamshedpur), Dr. S. P. Agharkar (Bombay), Dr. K. D. Sawhney (Hyderabad), Dr. K. N. Bagchi (Calcutta), Prof. B. C. Guha (Calcutta), Dr. G. D. Bhalerao (Izatnagar), Dr. A. C. Ukil (Calcutta) and Mr. J. M. Sen (Calcutta).

Mr. J. M. Sen was elected Convener of the Sub-Committee.

The President suggested that the following gentlemen, who were interested in the work of this Sub-Committee, might be requested to become members of the Indian Science Congress Association and then members of the Sub-Committee on Science and its Social Relations.

With a vote of thanks to the Chair, the meeting terminated.

ANNUAL REPORT OF THE SUB-COMMITTEE ON SCIENCE AND ITS SOCIAL RELATIONS FOR THE YEAR 1947.

1. In February, 1947 the following documents were forwarded to the member of the Sub-committee who were also requested to forward their suggestions for the next year's symposium.

(*a*) Minutes of the meeting of the Sub-committee held at Delhi on 2. 1. 47, (*b*) Annual Report for the year 1946, (*c*) a copy of the opening address of Mr. P. H. Kutar at the Symposium in "The Social Aspects of Engineering" and (*d*) a Resume of the activities of the Sub-committee since its inception, with an Appendix on Aims and objects.

2. The following subjects were suggested by the members as being suitable for the next year's symposium:—

(1) From atomic fission to world disintegration or world state or the Atom Bomb and after or Science and Scientists in the atomic age, or the positive role of scientists in the Atomic age (by Dr. H. K. Mitra and Prof. D. D. Kanga), (2) Statistics in relation to human welfare (by Prof. P. C. Mahalanobis, (3) Food *versus* Currency (by Prof. Gilbert Fowler), (4) Science in its relation to nationalism, industrialism and communism (by Prof. P. Ray, (5) Science and the conflict of cultures, including the need for training in Social Sciences at University centres (by Dr. K. Motwani), (6) Agriculture in relation to Social Welfare in India (by Dr. K. Sawhney), (7) Psychology in the service of man (by Mr. J. M. Sen), (8) Tribal administration (by Dr. A. Chatterjee), (9) Parasitology in relation to national economy (by Dr. G. D. Bhalerao), (10) Social work in India (by Prof. B. K. Sarkar), (11) Food and World population, or Drug addition and Civilisation, or Medicine and Human welfare (by Dr. B. Mukerji).

3. A meeting of the Sub-committee was held on 25. 6. 47 to finally choose the subject and to select the opener for the Symposium to be held at the Patna session of

the Science Congress to be held in January, 1948. It was proposed that Prof. B. C. Guha be requested to open the symposium on "Food and World Population." It was also proposed that Prof. P. C. Mahalanobis, Dr. Radhakamal Mukherji and V. K. R. V. Rao be invited to contribute to the Symposium. They were written to on 29. 7. 47, and lately advance copies of the printed address of Prof. B. C. Guha have been sent to them for perusal and preparation of their own notes.

4. Prof. H. J. Bhabha was requested to suggest if and how the Indian Science Congress Association could co-operate with UNESCO, particularly with regard to the activities of the Sub-committee on Science and its Social Relations. No reply has yet been received from Prof. Bhabha.

5. In terms of the decision contained in clauses (*b*) and (*c*) of the Scope of the Indian Science Congress (1946), the members of the Sub-committee were requested to write popular articles on selected subjects indicating the lag between scientific advance and its applications to human welfare in India. As a result of this appeal, the following contributions have been received for publication in some of the leading journals of India:—

(1) Food *versus* Currency by Gilbert Fowler.
(2) The fundamentals of the new Indian Civilization by Prof. D. D. Kanga.

6. In view of the fact that the Indian Science Congress Association, through its Sub-committee on Science and its Social Relations has been discussing the impact of Science on society and in view of the fact that the Inter-University Board and the Central Advisory Board of Education had passed resolutions requesting the Indian Universities to introduce Sociology as a subject for study in the undergraduate and post-graduate stages of the curriculum, the Committee requested Dr. K. Motwani to make a study of the status of Sociology in the various Universities in India. The different universities in India were addressed in July, 1947. The following is a summary of the replies received up to the end of November, 1947.

(1) *University of Mysore*—The subject is included in the curriculum for the Pass and Honours Degree Course.
(2) *University of Delhi*—No provision.
(3) *University of Ceylon*—The University has agreed in principle to the establishment of a Chair in Social Sciences and arrangements are being made to appoint a suitable Professor from Overseas.
(4) *University of Dacca*—Sociology is a subject for graduate and Post-graduate courses. It forms a paper in the M.A. course in Philosophy and a paper in B.A. Honours course in Political Science.
(5) *University of Agra*—The subject is included in the B.A. course, but not yet in the M.A. course. Only one affiliated college *viz.*, Indore Christian College has been recognised in Sociology for the B.A. Standard, but so far no classes have been started by that College.
(6) *University of Nagpur*—Sociology is an optional subject for the Intermediate in Arts and B.A. Examinations. The University has applied to the provincial Government for grant for the creation of a Chair in Sociology. The main difficulty is financial.

7. On account of certain unforeseen difficulties, the office of the Indian Science Congress Association could not print the Brochure on the scope, functions and activities of the Sub-committee. The Sub-committee requested the Executive Committee of the I. S. C. A. for 1948 to attend to this.

8. As all the correspondence connected with the work of this Sub-committee was carried on by the office of the Indian Science Congress Association the balance to the credit of the Sub-committee at the end of December, 1947 stood at Rs. 124-4-6, the same figure as at the end of 1946.

Submitted on behalf of the Sub-committee on 'Science and its Social Relations for the year 1947.

A. C. UKil,

Convener.

RESOLUTIONS OF SECTIONAL COMMITTEES

SECTION OF GEOLOGY AND GEOGRAPHY

(*i*) Resolved that the two members representing the sectional Committees be elected by the respective sectional Committees and not by the General Committee.

((*ii*) If necessary, the constitution be amended to give effect to the resolution.

SECTION OF BOTANY

The Botany Section of Indian Science Congress Association at its meeting held at Patna on the 7th January, 1948, considered the difficulties of Scientists desirous of carrying taxonomic studies of Indian plants arising from the non-availability of type-specimens of Indian species in the country and resolved to urge the Government of India to take necessary measures to make these available to Indian Botanists as early as possible.

During the course of discussion on the subject, it was pointed out that many type specimens went out of the country in the past owing to the absence of any regulations regarding their obligatory return to this country when Indian collections were sent out to specialists in Great Britain and other foreign countries for study and determination. This has been particularly the case with regard to specimens sent to Great Britain.

It was the usual Practice to send entire collections made by officers of the Government of India as well as the provincial governments in early days to relevant specialists and later to Kew for being worked out with the help of British and foreign specialists. When parts of these collections were returned, it was found that the types had been retained. Portions of the collections returned usually included only duplicates and triplicates while the most interesting specimens comprising those on which new species and varieties were almost invariably retained.

Even when vast collections of Indian plants, like the Wallichian Collections, made at the cost of the East India Company and later the Indian Governments were distributed, Indian Institutions were not included in these. It thus happens that the Sibpur Herbarium has no complete set of the Wallichian Collections, comprising more than 8,000 numbers. The same is true as regards many other collections distributed subsequently. Large collections were made by officers of the Botanical Survey or by officers of the Provincial Botanical departments (Bombay, Madras and Northern India), during the course of their duties have often been taken by them to England on their retirement from India, and finally deposited at Kew, British Museum or similar institutions abroad. The same may be said about the collections made by officers of the Agricultural, Forest and education department. which have mostly gone out of the country.

Now that the Government of India are contemplating the sending out of a fact finding Commission to England to determine the nature and ownership of the collections

of Indian House, the members of the Botany Section urge the Government of India to associate with the subject who will be able to help in determining the whereabouts of these priceless specimens and suggest measures for their being brought back to India.

2. The Botany Section also resolve to appoint a committee of the following to prepare a comprehensive memorandum regarding the subject and send it to the Government of India: (1) Prof. S. P. Agharkar (Secretary), (2) Dr. K. P. Biswas, and (3) Mr. A. K. Ghosh.

3. It is resolved that an advance copy of the above resolutions be sent to the Secretary, Agriculture and Education Department, Government of India, New Delhi.

SECTION OF ZOOLOGY AND ENTOMOLOGY

Resolved that the Section of Zoology and Entomology recommend to the Executive Committee that to ensure the transaction of Scientific business before the Congress in all seriousness, the following procedure may be adopted from the next Session:—

(*i*) Opening session should be held in the forenoon of the 2nd January and that the Sectional Committees should meet in the afternoon to conduct the official business of the section, to draw up a time table for the reading of the papers, and to consider matters of general importance pertaining to each section.

(*ii*) On the 2nd and the 3rd working days of the session, scientific meetings should be held both in the forenoon, and afternoon and that excursions and general meetings should not be arranged in these two days.

(*iii*) All sectional Presidential addresses should be so arranged as to be delivered on the 2nd and the 3rd working days, bearing in mind that no two addresses on biological or physical sciences subjects are taken up simultaneously. In the absence of the General President, the seniormost past president, of the section should preside when the Sectional address is read.

(*iv*) The abstracts in each Section should be classified into those to be read personally by the authors and those to be taken as read in absentia.

(*v*) So far as possible discussions should be recorded in the sectional Registers and that the Sectional President in collaboration with the members of the Sectional Committee should review the progress and trend of research for submission to the Executive Committee for publication in the proceedings.

SECTION OF PSYCHOLOGY AND EDUCATIONAL SCIENCE

(*i*) The Psychology and Educational Science Section of the 35th Indian Science Congress assembled at Patna (1948) unanimously resolves that the Government of India be requested to introduce Psychology in the list of subjects for selective examination of the Indian Administrative Service.

(*ii*) Resolved that the Government of India and the Governments of the constituents members of the Indian Union be requested to arrange for the full utilisation of Psychological Knowledge and technique in their expanding educational programmes by encouraging the Psychological research of educational problems, by the training of Sectional Psychologists and the establishment of Institutes of Applied Psychology.

(*iii*) Resolved that Dr. Zakir Hussain be authorised to take all necessary steps for implementing these resolutions and report to the section during the next Session of the Indian Science Congress.

ENGINEERING AND METALLURGY

Renaming of the Engineering and Metallurgy Section:

The question of renaming of the Engineering and Metallurgy section as printed in page 6 of the Annual Report was next discussed in the meeting. The Committee was unanimously of the opinion that, in view if the fact that this section was continually progressing year after year owing to the increased interest taken by the Engineering profession in the Indian Science Congress, that an Indian Institution of Chemical Engineers and an Indian Institute of Metals were recently formed in India, the existing name of the Section should not be changed at present.

11. RULES AND REGULATINS

RULES

1. The name of the Association shall be the Indian Science Congress Association, and its objects shall be the advancement of Science in India by the annual holding of a Congress and the doing of all such things as are incidental or conducive to the above object, including—

   (*a*) the holding and management of funds and property;

   (*b*) the acquisition of rights and privileges necessary or convenient for the object of the Association;

   (*c*) the management, development, improvement, disposal and sale of all and any parts of the property of the Association.

2. The Association shall consist of Ordinary Members, Sustaining Members, Benefactors, Honorary Members and Session Members.

3. Ordinary Members of the Association shall have the right to contribute papers for reading at the Session of the Congress, to receive free of charge all publications issued by the Association, and to fill any office in the Association on being duly elected thereto.

4. The annual subscription of Ordinary Members shall be Rs. 12. The subscription shall become due on the 1st February of each year and shall only be effective as payment for Ordinary Membership subscription if received before the 15th July of the year.

5. Any Ordinary Member may compound for the payment of all future annual subscriptions by the payment in a single sum of Rs. 150.

6. Any Ordinary Member agreeing to pay one additional subscription (Rs. 12) during his period of membership shall be called Sustaining Member.

7. Any person paying a lump sum of Rs. 500 or more or any institution paying a lump sum of Rs. 1,000 or more shall be a Benefactor of the Association, subject to the approval of the Executive Committee. Benefactors shall have all rights and privileges of Ordinary Members during their lifetime.

An institutional Benefactor shall have the right to nominate one person as Ordinary Member of the Association.

8. Honorary Member shall have all the rights and privileges of Ordinary Members Honorary Members, the number of whom shall be limited to fifteen at any one time, shall be persons eminent for their contributions to science or persons who have rendered conspicuous services to the cause of science in India.

Honorary Members shall be unanimously nominated by the Executive Committee subject to confirmation by the Council and the General Committee at its annual meeting. Not more than one Honorary Member shall be elected in any year.

9. There shall be three classes of Session Members:—
(*a*) Full Session Member—subscription Rs. 12 per Session.

(*b*) Associate Session Members—subscription Rs. 5 per Session.

(*c*) Student Session Members—subscription Rs. 2 per Session.

10. Full Session Members shall have the right to contribute papers for reading at the Session of the Congress, and to receive free of charge all publications issued by the Association relating to the Session of the Congress of which they are Members.

Associate and Student Session Members shall have the right to submit papers for reading at the Session of the Congress of which they are Members, provided such papers be communicated through an Ordinary or an Honorary Member of the Association.

A Student Member shall before admission be duly certified by the head of his or her institution to be a *bonafide* student.

Associate and Student Session Members shall receive free of cost the Abstracts of Paper contributed for the Session of which they are members.

11. The official year of the Association shall commence from the 1st of February.

12. There shall be Officers of the Association consisting of the members of the Executive Committee and Presidents and Recorders of Sections.

13. Only Ordinary and Honorary Members shall hold office in the Association.

14. The term of office of all Officers of the Association except the President shall commence from the beginning of the official year and shall extend until the assumption of office by their successors, appointed in accordance with the provisions of these Rules. The President shall assume office on the opening day of the Annual Congress following the one at which he is appointed, and shall continue to hold office until the assumption of office by his successor.

15. There shall be an Executive Committee which shall carry on the administrative work of the Association and submit such questions as it thinks desirable to a General Committee at its Annual Meeting during the Session of the Congress or at a Special Meeting of which due notice shall have been given.

16. The Executive Committee shall consist of the President, the President-elect for the following year, the two General Secretaries, the Treasurer and ten Members, Ordinary or Honorary, elected by the General Committee. For the purpose of this election any Ordinary or Honorary Member may propose the name of an Ordinary or an Honorary Member for election to the Executive Committee. Such proposal must be seconded by another Ordinary or Honorary Member and must reach the General Secretary before the 15th September. The Executive Committee shall circulate the names, together with such other names, not exceeding three, as it may suggest, to all Ordinary and Honorary Members for election by ballot. The ballot papers will be scrutinized by the President or his nominee and the General Secretaries, and the results of the ballot will be announced at the meeting of the General Committee.

Ordinary or Honorary Members, who have been elected members of the Executive Committee for three successive years, shall not be eligible for election as members for a period of two years after the completion of their term of appointment.

The Executive Committee shall co-opt as member at least one and not more than two Local Secretaries for the ensuing Session of the Congress.

17. The Executive Committee shall have full power to transact all business in cases of emergency, notwithstanding any limitations hereinafter laid down, and to deal with all matters not otherwise provided for in these Rules, including the making of such Regulations as may appear conducive to the good administration of the Association and the attainment of its object; provided always that such Regulations be not inconsistent with anything contained in these Rules, that they be reported for the information of the next meeting of the General Committee, and that they be subject to rescission or alteration by the Executive Committee or by any meeting of the General Committee.

18. There shall be a General Committee which shall consist of all Ordinary and Honorary Members of the Association.

19. The General Committee shall meet at least once during each Session of the Congress, preferably, in the middle of the Session.

20. There shall be a Council which shall consist of all Members of the Executive Committee, and all such Ordinary and Honorary Members of the Association as have held office as President, General Secretary, Treasurer, or Managing Secretary of the Association, the Sectional Presidents for the ensuing Session, and in addition seven Members of the Association, Ordinary or Honorary, elected by the General Committee, For the purpose of this election any Ordinary or Honorary Member may propose the name of an Ordinary or an Honorary Member for election to the Council. Such proposal must be seconded by another Ordinary or Honorary Member and must reach the General Secretary before the 15th September. The Executive Committee shall circulate these names, together with such other names, not exceeding three, as it may suggest, to all Ordinary and Honorary Members for election by ballot. The ballot papers will be scrutinized by the President or his nominee and the General Secretaries, and the results of the ballot will be announced at the meeting of the General Committee.

21. The function of the Council shall be to act as a body of advisers to be consulted by the Executive Committee on important questions of policy or scientific import.

22. There shall be a President who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

23. There shall be two General Secretaries (one of whom shall be resident in Calcutta) who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

24. There shall be a Treasurer who shall be nominated by the Executive Committee and whose nomination shall be submitted for confirmation to the General Committee at its Annual Meeting during the Session of the Congress.

25. The term of office of each General Secretary and of the Treasurer shall be for a period of five years following the confirmation of the appointment by the General Committee. They shall not be eligible for re-election to the office for a period of three years after the termination of their appointment.

26. In the event of a vacancy amongst the General Secretaries and the Treasurer occurring between two Sessions of the Congress the Executive Committee shall have power to appoint a General Secretary or the Treasurer for the period up to the termination of the next Session of the Congress.

27. There shall be a Local Secretary or Local Secretaries for each Session of the Congress who shall be appointed by the Executive Committee.

28. There shall be a Local Committee for each Session of the Congress which shall be appointed by the Executive Committee.

29. The Local Secretary, or Secretaries, and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

30. For the purpose of scientific deliberations during the Session of the Congress there shall be such Sections corresponding to different branches of science as may from time to time be constituted by the General Committee on the recommendation of the Executive Committee. It shall be competent for any Section after the first day's meeting to hold its scientific meetings in sub-sections for the purpose of dealing separately with different groups of papers submitted to that Section. A separate Chairman may be appointed by the Sectional President in consulation with the Sectional Committee to preside over each sub-section.

31. There shall be in each Section a President and a Recorder, who shall be appointed by the Sectional Committee in accordance with the procedure laid down in Regulation 1(8). Where this procedure has not been followed, these appointments shall be made by the Executive Committee. The appointments shall be placed for confirmation before the General Committee. In addition there shall be a Sectional Correspondent and a Local Sectional Secretary, who shall be appointed by the Executive Committee.

32. In each Section there shall be Sectional Officers, namely, a President, a Recorder, a Sectional Correspondent, and a Local Sectional Secretary. The President and the Recorder shall be the chief executive officers of the Section. They shall have power to act on behalf of the Sectional Committee in any matter of urgency which cannot be brought before the Sectional Committee for consideration, and they shall report such action to the Sectional Committee at its next meeting.

The work of each Section shall be conducted by a Sectional Committee which shall be constituted as follows:—

(*a*) Sectional Officers.

(*b*) All Ordinary and Honorary Members of the Association who have been Presidents or Recorders of the Section.

(*c*) Two Members of the Association, Ordinary or Honorary, elected by the General Committee at its Annual Meeting during the Session of the Congress.

The Sectional President shall preside over all meetings of the Section and of the Sectional Committee. He shall be the convener of the meetings of the Sectional Committee. His ruling shall be final on all points of order that may arise.

The Sectional Recorder shall act as the Secretary of the Sectional Committee, and shall maintain a proper record of the proceedings of the Sectional Committee and of the Section in a book provided for the purpose. He shall be responsible for the punctual transmission to the General Secretary of the recommendations adopted by the Sectional Committee, and of resolutions adopted by the Section.

The Sectional Correspondent shall be resident at the headquarters of the Association, and shall be responsible for preparing for the press the material relating to his Section, according to the instructions of the Sectional President.

The Local Sectional Secretary shall be resident in the locality where the Annual Session is held, and shall be responsible for all local arrangements for the work of his Section, and for arranging the Sectional excursions in consultation with the Local Secretaries.

33. The Sectional Committee shall meet on the opening day of each Session of the Congress, and daily thereafter during the Session before the meeting of the Session unless otherwise determined at a meeting of the Sectional Committee.

In the absence of the Sectional President from any of its meetings the most senior member of the Sectional Committee present shall take the chair.

In their meeting on the opening day they shall

(a) elect a Sectional President and a Sectional Recorder for the ensuing year in accordance with the procedure laid down in Reg. 1 (8);
(b) determine the detailed arrangements for the Sectional meetings;
(c) select the papers to be read and discussed;
and in their meetings during the Session they shall also
(d) nominate a Sectional Correspondent and a Local Sectional Secretary for the ensuing year for the consideration of the Executive Committee;
(e) determine the contents of the Sectional records in the Proceedings in accordance with Rule 34(e);
(f) consider means of improving the scientific work of the Section, and make suggestions to the Executive Committee whenever considered necessary;
(g) select topics for discussions at the next Session of the Congress and make necessary arrangements (i) through the President of the Section concerned for discussions within a Section, and (ii) through the Sectional President who has initiated the proposal for a discussion in which more than one Section will participate.

34(a) All papers submitted for reading at the next Session for the Congress shall be forwarded to the General Secretary so as to reach him not later than September 15th of the calendar year preceding the Session of the Congress at which the papers are intended to be read, provided that this date may be changed by the Executive Committee for special reasons.

(b) Any paper submitted for reading at the Section of the Congress shall be accompanied by an abstract in triplicate.

(c) All papers submitted for reading at a Session of the Congress shall be checked by the Sectional Correspondent concerned or by such person or persons appointed by the General Secretary. The paper together with a copy each of the abstracts shall then be sent to the Sectional President concerned for refereeing and acceptance. Decisions with regard to acceptance or rejection of any paper shall be final and all reports confidential.

(d) No paper published elsewhere shall be accepted.

(e) Only abstracts of the paper received by the General Secretary before September 15th in accordance with Rule 34(a), (b) and (c) shall be printed in Part III of the Proceedings. In exceptional circumstances, abstracts of papers received after that date and read before the Section, if specially recommended by the Sectional Committee, may be printed in Part IV.

35. The Proceedings of the Indian Science Congress Association shall be published in one volume in four separate parts, as follows:—

I. To contain the list of officers, the Proceedings of the opening meeting (except the General President's Address) and all official matters.

II. To contain the Presidential Addresses. To be distributed to those present at the meeting after the addresses have been delivered, and to absent Ordinary, Honorary and Full Session Members by post after the meeting.

III. To contain the abstracts of papers to be read before the Sections which are received before September 15th in accordance with Rule 34(*a*). No abstracts shall be included in this volume from authors who have not enrolled themselves as Members of the Association. To be distributed in advance of the meeting to all Members of the Association.

IV. To contain the discussions, the abstracts accepted in accordance with Rule 34(*e*), the list of members and the index.

36. The following procedure shall be observed for the making of any addition to or alteration in the Rules of the Association:—

(*i*) Proposals for additions to and alterations in the existing Rules may be placed at any time before the General Committee by the Executive Committee.

(*ii*) (*a*) Proposals for additions to and alterations in the existing Rules by any Ordinary or Honorary Member of the Association shall be sent to one of the General Secretaries so as to reach him two full months before the meeting of the General Committee in which they are to be moved.

(*b*) One of the General Secretaries shall circulate such proposals to all Ordinary and Honorary Members of the Association at least one full month before the General Committee.

(*c*) Any amendments to the proposals shall be sent by any Ordinary or Honorary Member of the Association to one of the General Secretaries so as to reach him at least a fortnight before the meeting of the General Committee.

(*d*) The proposals together with any amendments shall be brought up before the meeting of the General Committee at the Annual Meeting during the Session of the Congress together with any remarks of the Executive Committee and declared carried if accepted by a two-thirds majority of the constituent Members present and voting at the meeting.

(*Adopted* the 5th January, 1931. *Revised* the 5th January, 1935, the 6th January, 1936, the 5th January, 1937, the 8th January, 1939, the 6th January, 1940, the 5th January, 1942, the 4th January, 1943, the 5th January, 1945 and the 5th January 1948).

REGULATIONS

I. Sectional Officers.

(1) The President delivers a Presidential Address of which ordinarily the cost of printing 16 pages of the Proceedings in its usual form shall be borne by the Indian Science Congress Association and any author exceeding the limit shall bear the extra cost, provided that in no case the Presidential Address shall exceed 25 pages. The time available for delivery of the Presidential Address shall usually not exceed 25 minutes. The manuscript of the address, ready for the press, should be received by the General Secretary before October 15th of the calendar year preceding the Session of the Congress at which the address will be delivered, provided that this date may be changed by the Executive Committee for special reasons. It should be accompanied by 12 copies of a short popular summary (about 500 words) for issue to the lay press. The time and date of the delivery of the President's Address will be communicated before the meeting of the Congress. No two Presidential Addresses will be delivered at the same time.

(2) The President shall be entitled to receive 30 copies of his address without charge, and additional copies at the cost of reproduction.

(3) Railway fares, postage, clerical or other expenses incurred by the Sectional Presidents will not be paid by the Association.

(4) The following procedure is adopted for the collection of papers for the Sections:—

About the middle of April a number of copies of a printed circular will forwarded to the President of each Section who may arrange to send these to workers in that branch of science with which his Section is concerned, requesting them to contribute papers for reading before the next meeting of the Congress.

The circular will contain a clause inviting such workers as are not yet Ordinary Members of the Association to join as such. Particular note should be taken of the fact that no new Ordinary Members are enrolled after the 15th July of the year.

In the case of joint papers, each author must be a Member of some category.

(5) The President referees, either in person or by proxy, the papers received for reading before his section in accordance with Rule 34.

Abstracts should be limited, except in very special cases, to about 200 words. Long abstracts should be reduced by the President, References to literature in abstracts should be avoided as far as possible and when given should conform to the system of abbreviation used by the Association.

The contents of all abstracts should be carefully checked by the Sectional Correspondent concerned or by such person or persons as appointed by the General Secretary and the abstracts shall then be sent to the Sectional President for his final scrutiny and approval.

Joint discussions on related papers may be held. Authors of papers should be informed of the time allotted by the President to the reading of their papers. An author contributing more than one paper should be asked to specify which of them he would prefer to read at the meeting.

(6) The President, in consultation with the Local Sectional Secretary, shall make arrangements for such local Sectional excursions as seem desirable. Due notice shall be given to the General Secretaries of all such arrangements.

(7) The President and the Recorder should, in consultation with other members of the Sectional Committee, make proposals to the General Secretary regarding the programme of the Section. Such proposals should reach the General Secretary not later than the 1st November, so as to enable the necessary details to be entered in the programme. General discussions on questions of importance, held either by a single Section or jointly by two or more Sections, should be encouraged.

The Sectional Presidents concerned shall communicate to the General Secretary before the end of July the titles of such discussions, the names of the speakers and such further information as may be considered necessary.

The Papers, together with three copies of abstracts, to be read by the contributors at a discussion shall be sent to the General Secretary on or before the 15th September of the preceding calendar year by the Sectional President concerned.

The materials relating to a discussion, in a form ready for the press, shall be communicated to the General Secretary within a month from the date on which the discussion takes place; the material not received by the General Secretary within this period shall not be published.

The President and the Recorder of the Section arranging a discussion shall carry out the necessary correspondence throughout the year during which they hold office.

(8) Early in November copies of a printed form will be issued to Presidents of Sections for circulation to members of the Sectional Committees requesting them to nominate a President and a Recorder for the ensuing meeting for consideration by the Sectional Committee. Such proposals shall be accompanied by a statement of qualifications of the nominees for the office and their willingness to accept the same if elected thereto.

During the first week of December, the President of each Section shall circulate all such proposals received by him, together with the statements of qualifications, to the members of the Sectional Committee and request them to nominate by ballot one member for each office from among the list circulated, the ballot papers being received by him up to the 20th December.

At the first meeting of the Sectional Committee held on the opening day, the ballot papers shall be opened and scrutinized as the Chairman shall direct and the result communicated to the Executive Committee for consideration, together with a complete record of the Proceedings in this connection.

(9) The duties of the Sectional Correspondent and of the Local Sectional Secretary are given in Rules 32 and 34 (c).

(10) All persons entitled to be members of the Sectional Committee should enrol themselves without delay as Ordinary Members if not already so enrolled and should inform the General Secretary of the payment of their subscription when accepting the appointment.

(11) The General Secretary should be consulted whenever any question arises not dealt with in these regulations.

II. Local Arrangements

In accordance with the Rules of the Association, the Local Secretaries and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for holding the Session of the Congress.

The following arrangements have to be made:—

A. Accommodation for the Scientific Meetings

(1) A large hall should be available for (*a*) the President's address on the opening day, and (*b*) for the evening lectures. Both (*a*) and (*b*) are open to the public free of charge. A projection lantern with an operator should be available in this room, and it is a great advantage if loud speakers can be installed.

(2) Rooms for the meetings of the different Sections of the Congress should be provided and suitably furnished. An epidiascope with an operator should be provided in each sectional room. All the rooms should be as far as possible in close proximity. The following are the Sections of the Congress:—

Mathematics, Statistics, Physics, Chemistry, Geology and Geography, Botany, Zoology and Entomology, Anthropology and Archæology, Medical and Veterinary Sciences, Agricultural Sciences, Physiology, Psychology and Educational Science, and Engineering and Metallurgy.

(3) A Reception room should be provided in which members can get information, write letters, etc. The Local Secretaries' Office should be as near as possible to this room. An arrangement should be made with the Postmaster-General to have a temporary Post Office in this room for all letters addressed to members c/o The Indian Science Congress to be delivered here. The Indian Science Congress Post Office should be situated as near as possible to the Reception room.

(4) A room near the Reception room should be set apart for the General Secretaries' Office, which will be opened therein from the 31st December.

(5) Provision should be made for lunch in European and Indian styles at moderate charges near the Reception room.

B. Accommodation for Visiting Members

The Local Secretaries should send out, not later than the end of November, a printed circular to all members enrolled, asking them if they desire that accommodation should be arranged for them. It is desirable, as far as possible, to provide private hospitality for the President, Sectional Presidents and Officers of the Congress. In this circular information should be given regarding the types of accommodation available, with the charges, and the nature of the climate during the Session. The Local Secretaries will receive periodically from the General Secretary list of members enrolled at headquarters.

C. Programme of the Meeting

(1) (*a*) The Sections of the Congress meet daily in the morning generally from 9-30 A.M.

(*b*) Presidential Addresses of the Sections shall commence from 9-30 A.M.

(*c*) There should be no afternoon Presidential Addresses of the Sections.

(*d*) Symposia or joint discussions will be held either in the morning or from 2 P.M.

(2) Public lectures are arranged by the Executive Committee, and are given at 6 P.M. or 6-30 P.M.

(3) A printed guide with a map of the locality in which the Congress is held should be prepared for distribution to members on the opening day. Only Ordinary, Honorary and Full Session members are entitled to the Guide Book free of cost. A small charge not exceeding Re. 1 (to be fixed by the Local Committee) may be made to other members desiring to have a copy. The Guide Book should contain a summary of information concerning the scientific and educational activities and a short history of the locality, in addition to general information likely to be of use to visitors.

(4) Arrangements should be made for giving the publicity to the activities of the Congress, both before and during the meeting.

(5) A list of members with their local addresses where known should be printed and distributed on the opening day. A supplementary list should be typed and posted in the Reception room and maintained up-to-date. The Local Secretaries shall arrange for this.

(6) A provisional programme of social engagements should be drawn up by the Local Secretaries and sent to the General Secretary by the 25th November. It is essential that this be sent in time, as it has to be printed and distributed with the abstracts by the first week of December.

The General Secretary will make arrangements for printing the programme drafted as above and distributing those to members enrolled at the time of the distribution of the abstracts.

The final programme shall be printed locally by Local Committee in time for the opening of the Session.

D. General

(1) Numbered badges for members of the Congress will be sent by the General Secretary to the Local Secretaries for distribution on the opening day of the meeting. The badges should bear numbers corresponding to the enrolment numbers. There should be additional badges for Officers.

(2) Members of the Local Reception Committee who have made substantial contributions to the funds of the Local Committee may be given complementary tickets to attend the meetings.

(3) An audited copy of the accounts of the Local Committee should be sent to the General Secretary not later than the 30th April, following the Session, for inclusion in the Proceedings of the Session. It is desirable that the Local Committee should contribute any surplus to the reserve fund of the Association.

(4) Twelve copies each of all local publications connected with the Congress (Guide Book, final programme, notices, cards, etc.) should be sent to the office of the Association for record at the conclusion of the meeting.

(5) Applications for membership will ordinarily be dealt with by the General Secretary at the Office of the Association up to the 15th December. After that date applications for membership will be forwarded to the Local Secretaries, who will open a separate account for the sale of membership tickets. The amount thus realized, together with unsold tickets, should be forwarded to the General Secretary immediately after the close of the Congress.

III. FINANCIAL

(1) The accounts of the Association shall be audited once a year and the books closed on the 30th November each year for this purpose.

(2) The audited accounts shall be placed before the General Committee at the Annual Meeting with the observations, if any, of the Executive Committee.

(3) Sanction for all payments for amounts exceeding Rs. 100 shall be obtained from the Finance Committee which shall consists of the General Secretaries, the Treasurer and one Ordinary or Honorary Member resident in Calcutta who shall be nominated by the Executive Committee.

(4) Amounts received on account of Life Membership Subscription shall be credited to the Reserve Fund of the Association.

IV. ELECTION OF REPRESENTATIVES OF ASSOCIATION BY THE EXECUTIVE COMMITTEE

(1) A letter shall be issued asking for nominations giving a last date therefor.

(2) The proposer should ascertain whether the person he proposes is desirous of serving in that particular capacity.

(3) After the nominations have been received the names should be circulated in a ballot paper and the date for return should be fixed two weeks after the ballot paper is sent out.

V. NOMINATION OF GENERAL PRESIDENT

(1) The General Secretary shall invite nominations for the office of General President of the Association, two years in advance, by a circular letter to the members of the Council, not later than the 15th of October. Such circular shall include a list of the General Presidents of the past 15 years, and the branches of science in which they had specialized.

Nominations shall reach the General Secretary not later than the 15th of November.

(2) The General Secretary shall circulate the nominations received to the members of the Executive Committee for expression of opinion on or before the 30th November. Such opinions shall reach the General Secretary not later than the 15th of December.

(3) The nominations, together with the views of members thereon, shall be placed for decision before a meeting of the Executive Committee to be held on the day previous to the commencement of the Session of the Congress.

(*Adopted* the 5th January, 1937. *Revised* the 8th January, 1939, the 6th January, 1940, the 6th January, 1941, the 5th January, 1942, the 4th January, 1943 and the 5th January, 1945).

THE INDIAN SCIENCE

Receipts and Payments Account for

RECEIPTS.

To Balance.		
„ Reserve Fund:		
„ Govt. papers.	17,881 11 4	
„ Bank account.	1,361 1 0	19,242 12 4
To Balance.		
„ Imperial Bank of India General account.	17,308 3 1	
„ Cash in Hand	111 14 5	17,420 1 6
To Balance of Advance in last year, M|s. Goven Brothers	280 0 0	
„ General Secretary.	910 0 0	1,190 0 0
„ Subscription received.		16,935 4 0
„ Sales proceeds of publications. ..		977 14 0
„ Govt. grant and contribution. ..		84,00 0 0
„ Reserve Fund Account.		
„ Life membership fee received. ..	451 0 0	
„ Interest & Profit from security. ..	398 0 0	849 0 0
	Rs.	65,014 15 10

Examined and found correct.

P. C. NANDI & CO.

Auditors.

Chartered Accountant.

Registered Accountant.

The 12th March, 1948.

6, Hastings Street, Calcutta.

CONGRESS ASSOCIATION

the year ended 30th November, 1947.

PAYMENTS

By Salary & Allowance.	5,602	2	0				
„ Printing & Paper	20,841	3	3				
„ Postage	1,418	1	0				
„ Contingencies	1,026	2	3				
„ Railway freight.	439	14	6				
„ Travelling.	627	4	0				
„ Expenses on visits of foreign scientists. ..	3,005	4	0				
„ Stationery & Stores	198	3	3				
„ Office Rent	675	0	0				
„ Bank Charges	50	8	1				
„ Miscellaneous	139	2	0	34,022	12	4
Furniture & fittings				1,379	7	9
Advance to Patna General Secretary				5,000	0	0
By Balance of Reserve Fund:						
Govt. Papers.	12,977	9	10			
Bank Account.	7,084	6	6	20,062	0	4
„ Cash at Imperial Bank of India Co.	4,333	3	11			
„ Cash in Hand.	217	7	6	4,550	11	5
				Rs. 65,014	15	10

THE INDIAN SCIENCE

Budget Estimates for the year from

RECEIPTS

Particulas	Rs.	A.	P.
Membership Fees	19,000	0	0
Govt. of India Grant	15,000	0	0
Sale of Publications	1,000	0	0
Interest on Reserve Fund investments	,400	0	0
Rs.	35,400	0	0

* Accounts pertaining to the visit of the Foreign Scientists have been kept separate according to Government instructions.

CONGRESS ASSOCIATION

1st December, 1947 to 30th November, 1948.

EXPENDITURE

Particulas	Rs.	A.	P.
Salary & D. A. to office staff	12,000	0	0
Office rent including Store room	3,500	0	0
Printing	32,000	0	0
Postage and Telegrams	2,000	0	0
Travelling Allowance	800	0	0
Auditors Fee	50	0	0
Allowance for attending Executive Committee meetings during the session	5,000	0	0
Contingency, Railway freight and local conveyance	650	0	0
Stationary & Badges	500	0	0
Furniture & fittings	5,000	0	0
Office equipment	2,500	0	0
Rs.	64,000	0	0

INDIAN SCIENCE CONGRESS ASSOCIATION

THIRTYSIXTH YEAR

1st February, 1948—31st January 1949.

NOTICES

LISTS OF OFFICERS, SECTIONAL COMMITTEES AND ORDINARY MEMBERS

1, PARK STREET, CALCUTTA 16
OCTOBER 1948.

NOTE

The List of Members is printed in Part IV of the Proceedings which will be issued after the session by the middle of the following year.

Any inaccuracy or omission in the present list may kindly be reported to the General Secretary at 1, Park Street, Calcutta 16.

INDIAN SCIENCE CONGRESS ASSOCIATION

THIRTYSIXTH ANNUAL MEETING, 1949

GENERAL INFORMATION

The Thirtysixth Annual Meeting will be held at Allahabad from January 2nd to January 8th, 1949.

Her Excellency Mrs. Sarojini Naidu, the Governor of U.P. has kindly agreed to be the Patron of the Meeting.

Sir K. S. Krishnan, F.R.S., will preside over the Meeting.

The names and addresses of the Sectional Presidents are given in the following pages.

LOCAL ARRANGEMENTS

All enquiries about accommodation and other local arrangements should be addressed to the Local Secretaries, 36th Indian Science Congress, University of Allahabad, Allahabad. Early intimation of the accommodation required should be sent to the Local Secretaries.

MEMBERSHIP CARDS AND LITERATURE

Ordinary Membership cards have been forwarded to all Ordinary Members.

A detailed provisional programme of the Thirty-sixth Meeting of the Congress will be issued to all Ordinary Members in course of December of this year, together with a copy of Part III of the Proceedings containing Abstracts of the Paper accepted for reading at the different Sections.

Parts I (Official matters), II (Presidential Address) and IV (Discussions) of the proceedings will be issued by the middle of the following year.

THIRTY-SEVENTH ANNUAL MEETING, 1950

Subscription notice will be sent out to all Ordinary Members on the register after the 1st February, 1949. This will be followed, after a suitable interval, by the Ordinary Membership cards for the year 1949-50 per V.P.P. for the amount of the subscription. Payment of the subscription fee of Rs. 12|- before the 15th July, 1949 will be only effective for continuance of Ordinary Membership during the ensuing year, covering the Thirty-sseventh Annual Meeting.

APPLICATION FOR MEMBERSHIP

Application for new Ordinary Membership should furnish the following particulars. No form is necessary.

1. Name in full with degrees and titles.
2. Appointment, designation or profession.
3. Full address where correspondence is to made.

This should reach the office of the Association at 1, Park Street, Calcutta-16 before the 15th July, 1949.

INDIAN SCIENCE CONGRESS ASSOCIATION

THIRTY-SIXTH YEAR: 1st FEBRUARY, 1948—31st January, 1949.

OFFICERS OF THE ASSOCIATION

PRESIDENT-ELECT

Sir K. S. Krishnan, F.R.S.

PRESIDENT

Col. Sir Ram Nath Chopra, Kt. C.I.E., M.A. M.D., F.R.A.S.B., F.N.I., I.M.S., (Retd.)

GENERAL SECRETARIES

Dr. B. Mukherji, D.Sc., M.D., M.P.S., F.A.Ph.S., F.N.I.
Dr. B. Sanjiva Rao, M.A., Ph.D., D.Sc., F.N.I.

TREASURER

Prof. P. Ray, M.A., F.N.I.

LOCAL SECRETARIES

Dr. Shri Ranjan, M.Sc., Docteur-es-Sciences F.A.Sc.
Mr. A. C. Banerji, M.A., M.Sc., F.R.A.S., F.N.I., I.E.S. (Retd.)

EXECUTIVE COMMITTEE

1.	Col Sir R. N. Chopra, Kt., C.I.E., M.A., M.D., F.N.I., I.M.S. (Retd.).	*President.*
2.	Sir K. S. Krishnan, F.R.S.	*President-Elect.*
3.	B. Mukherji, D.Sc., M.D., M.P.S., F.A.Ph.S., F.N..I, ...	*General Secretaries.*
4.	Dr. B. Sanjva Rao, M.A., Ph.D., D.Sc., F. N. I, ...	
5.	Prof. P. Ray, M.A., F.N.I., ...	*Treasurer.*

6. Rai Bahadur Dr. K. N. Bagchi, B.Sc., M.B., F.I.C., D.T.M., F.N.I. .. ..
7. Prof. K. N. Bhal, D. Sc., D. Phil., F.R.A.S.B., F.N.I., ...
8. Dr. U. P. Basu, D.Sc., P.R.S., F.N.I. ..
9. Dr. B. C. Guha, Ph. D., D.Sc., F.N.I. ..
10. Dr. G. P. Mazumdar, M.Sc., Ph.D., F.N.I., ..
11. Dr. Baini Prasad, O.B.E., D.Sc., F.R.S.E., F.L.S., F.Z.S., F.N.I., ...
12. Prof. B. Sanjiva Rao, M.A., Ph.D., D.Sc. F.N.I.
13. Dr. A. C. Ukil, M.B., M.S.P.E., F.S.M.F.B., F.N.I., ...
14. Dr. K. Venkataraman, D. Sc., F.I.C., A.M.I., Chem.E., ...
15. Dr. W. D. West, M.A., Sc.D., F.N.I. ..

} *Elected by the General Committee.*

16. Dr. Sari Rahjan, M.Sc., Docteur-es-Sciences F.A.Sc., ...
17. Prof. A. C. Banerji, M.A. M.Sc., F.R.A.S., F.N.I. I.E.S.. (Retd.). .. ..

} *Local Secretaries.*

COUNCIL

—17(a) **Members of the Executive Committee**

(b) **Past Presidents who are either Ordinary or Honorary Members**

18. Sir M. Visvesvaraya, K.C.I.E., M. Inst., C.E., D.Sc.
19. Prof. J. L. Simonsen, D.Sc., F.I.C., F.R.S.
20. Sir Chandrasekhara Venkata Raman, Kt., Nobel Laureate.
21. Sir Lewis Leigh Fermor, Kt., O.B.E., D.Sc., F.G.S., A.R.S.M., M.Inst. M.M. F.R.A.S.B., F.N.I.
22. Prof. M. N. Saha, D.Sc., F.R.S , F.R.A.S.B., F.N.I.
23. Dr. J. H. Hutton, C.I.E., M.A., D.Sc., F.R.A.S.B,, F.N.I.
20. Sir T. S. Venkataraman, Kt., C.I.E., D.Sc., F.N.I.
25. Sir Jnan Chandra Ghosh, Kt., D.Sc., F.N.I.
26. Prof. B. Sahni, Sc.D., D.Sc., F.R.S.
27. Sir Ardeshir Dalal, Kt., I.C.S. (Retd.).
28. Dr. D. N. Wadia, M.A., D.Sc., F.G.S., F.R.A.S.B., F.N.I.
29. Prof. S. N. Bose, M.Sc., F.N.I.
30. Sir S. S. Bhatnagar, O.B.E., D.Sc., F.R.S., F. Inst.P., F.I.C., F.N.I., F.S.C.I. (Hon.).
31. Prof. M. Afzal Husain, M.A., M.Sc., F.N.I.
32. Jawharlal Nehru.

(c) **Past General Secretaries who are either Ordinary or Honoray Members**

19. Prof. J. L. Simonsen, D. Sc., F.I.C., F.R.S.
20. Sir Chandrasekhara Venkata Raman, Kt., Nobet Laturcate.
33. Prof. S. P. Agharkar, M.A., Ph.D., F.I.S., F.N.I.
15. Dr. W. D. West, M.A., Sc.D., F.N.I.
34. Dr. J. N. Mukherjee, C.B.E., D.Sc. F.R.A.S.B., F.N.I.

35. Prof. P. Parija, O.B.E., M.A., I.E.S., F.N.I.
36. Prof. S. K. Mitra, M.B.E., D.Sc., F.N.I.
37. Prof. P. C. Mitter, Ph.D., F.N.I.
38. Prof. P. C. Mahalnabis, F.R.S., F.N.I.,

(d) Past Treasurers who are either Ordinary or Honorary Members.

19. Prof. J. L. Simonsen, D.Sc., F.I.C., F.R.S.
20. Sir Chandrasekhara Venkata Raman, Kt., Nobel Laureate.
11. Dr. Baini Prasad, O.B.E., D.Sc., F.L.S., F.Z.S., F.R.S.E., F.N.I.
39. Rai Bahadur Dr. S. L. Hora, D.Sc., F.L.S., F.Z.S., F.R.A.S.B., F.N.I.
34. Dr. J. N. Mukherjee, C.B.E., F.R.A.S.B., F.N.I.

40—52(e) **Sectional Presidents for the Session (see the following list.)**

(f) Elected by General Committee.

53. Dr. Basudeb Banerjee, Dr.Phill (Munich).
54. Dr. C. Barat, M. Sc., Dr.Ing.,
55. Dr. B. C. Basu, D. Sc.,
56. Capt. R. N. Basu, M.Sc., M.B., I.M.S.
57. Dr. H. J. Bhabha, Ph.D., F.R.S., F.N.I.
58. Dr. G. D. Bhalerao, D. Sc., Ph. D., F.Z.S., F.R.M.S., F.A.Sc.,
59. Dr. B. N. Prasad, D.Sc., Ph.D., F.N.I.,

SECTIONAL PRESIDENTS

Mathematics—S. Chowla, *The Institute for Advanced Study School of Mathematics Princeton, New Jersey.*

Statistics—Dr. U. S. Nair, M.A., Ph.D., F.N.I., *Professor of Statistics, University of Travancore, Trivandrum.*

Physics—Dr. R. S. Krishnan, M.A., D.Sc., Ph. D., (Cantab), *Professor and Head of the Department of Physics, Indian Institute of Science, Malleswaram, Bangalore.*

Chemistry—Dr. P. B. Ganguly, D.Sc., F.N.I., *Principal, Science College P.O Sankipore, Patna.*

Geology & Geography—Prof. C. Mahadevan, D.Sc., F.A.Sc., F.N.A.Sc., F.N.I., *Head of the Department of Geology, Andhra University, Waltair.*

Botany—Mr. M. S. Randhawa, M.Sc., I.C.S., F.N.I., *Deputy Commisoner, Delhi.*

Zoological & Entomology—Dr. M. L. Roonwal, M.Sc., Ph.D., (Cantab), F.N.I., *Zoological Survey of India, Kaisar Castle, Benares Cantt.*

Anthopology & Archaeology—Mr. Nirmal Kumar Bose, M.Sc., *Lecturer in Geography, University of Calcutta, Senate House, Calcutta.*

Medical & Veterinary Sciences—Dr. M. B. Soparkar, M.D., 117, *Khar, Bombay* 21.

Agricultural Sciences—Dr. R. S. Vasudeva, Ph.D., D.Sc., D.I.C. (Lond.), *Indian Agricultural Research Institute, New Delhi.*

Physiology—Dr. B. B. Sarkar, D.Sc., F.R.S.E., *Head of the Department of Physiology, University of Calcutta, University College of Science,* 92, *Upper Circular Road, Calcutta.*

Psychology & Educational Sciences—Mr. T. K. N. Menon, B.A., T.D., M.A.Ed., *Principal, Teachers Training College, Baroda.*

Engineering & Metallurgy—Prof. M. Sen Gupta, B. Sc., (Cal.) B.Sc. (England) Hons. Glas, C.P.E., (las.), M.I.E., (Lond.), M.I.E. (Ind.), A.M.I. Mech.E (Lond.), F.I.P.S. (Ind.), *University Professor and Head of the Department of Electrical Engineering, Principal, Engineering College, Beneres Hindu University, Beneres.*

SECTIONAL RECORDERS

Mathematics—Prof. P. N. Das Gupta, *Prof. of Mathematics, Science College, Patna.*

Statistics—Shree Sadashiv Sengupta, *Statistician, East Indian Railways, Netaji Subhas Road, Calcutta.*

Physics—Dr. P. S. Gill M.Sc., Ph.D., *Tata Institute of Fundamental Research, 53, Pedder Road, Bombay.*

Chemistry—Dukha Haran Chakravarti, D.Sc., *Lecturer in Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.*

Geology & Geography—Dr. S. C. Chatterjee, D.Sc., F.R.G.S., F.G.M.S., *Prof. of Geography, Patna College, Patna,*

Botany—Dr. R. L. Nirula, B.Sc., Ph. D., D.T.C., *Head of the Department of Botany, College of Science, Nagpur (C.P.).*

Zoology & Entomology—Dr. H. D. Shrivasalva, D Sc., *Research Officer Indian Veterinary Research Institute, Izatnagar, Bareilly, (U.P.).*

Anthropology & Archaeology—Mr. M. N. Basu, *Lecturer in Anthropology, University College of Science, 35, Ballygunge Circular Road, Calcutta.*

Medical & Veterinary Sciences—Dr. Harendra Nath Ray, M.Sc, Ph.D., (Lond.), *Protozoologist, Indian Veterinary Research Institute. Mukteswar, Kumaun, (U.P.).*

Agricultural Sciences—Mr. P. C. Raheja, M.Sc., *Indian Agricultural Research Institute, New Delhi.*

Physiology—Prof. N. P. Benwari. M.D., *Prof. of Physiology, Darbhanga Medical College, Darbhanga.*

Psychology & Educational Science—Prof. Kali Prasad, *Department of Philosophy, Lucknow University Lucknow.*

Engineering & Metallurgy—J. Ganguly, Esqr., B.E., M.I.E., (*Ind.*), 7|1|A, *Mohan Lal Street, Calcutta.*

SECTIONAL CORRESPONDENTS

Mathematics—Mr. U. R. Burman, M.Sc., *Lecturer in Applied Mathematics, University College of Science, 92, Upper Circular Road, Calcutta.*

Statistics—Mr. H. K. Nandi, M.Sc., *Lecturer in Statics, Calcutta University, Calcutta. versity, Calcutta.*

Physics—Dr. S. D. Chatterji D.Sc., *Research Fellow, Bose Research Institute 93, Upper Circular Road, Calcutta.*

Chemistry—Dr. T. N. Ghosh, D.Sc., A.I.I.Sc. *Bengal Immunity Research Laborator 153, Dharamtola Street, Calcutta.*

Geology &Geography—Mr. Subodh Chandra Bose, M.A., *Professor of Geography, Asutosh College.*

Botany—Mr. A. K. Ghosh, M.Sc., *Registrar, Bose Research Institute, Calcutta.*

Zoology &Entomology—Mr. J. N. Rudra, M.Sc., *Vidyasagar College, Calcutta.*

Anthropology & Archaeology—S. Sarkar, M.Sc., *Anthropological Survey of India Indian Museum, Calcutta.*

Medical & Veterinary Sciences—Dr. D. Panja, M.B., (Cal.), *School of Tropical Medicine, Calcutta*... .. ..

Agricultural Sciences—Mr. E. A. R. Banerjee, M.Sc., Dip. *Agri., Economic Botanist to the Govt. of West Bengal Govt., Agricultural Farm, Chinsurah (Hooghly).*

Physiology—Dr. N.N. Das, M.Sc., M.B., *Lecturer in Physiology, University College of Science, 92, Upper Circular Road. Calcutta.*

Psychology & Educational Science—Mrs. Santa Deb. M.A., B.T., T. D. (Lond.); *Department of Psychology, 92, Upper Circular Road, Calcutta.*

Engineering & Metallurgy—Dr. J. N. Basu, M.I.E., M.A.E., Dr. Eng. *Prof. of Mechanical Engineering, College of Engineering and Technology P.O. Jadavpur, Calcutta, 24-Parganas.*

LOCAL SECTIONAL SECRETARIES

Mathematics—Dr. P. L. Shrivastava, *Mathematics Department, University of Allahabad, Allahabad.*

Statistics—Mr. J. K. Mehta, *Economics department, University of Allahabad, Allahabad.*

Physics—Dr. R. N. Ghosh, *Physics Department, University of Allahabad, Allahabad.*

Chemistry—Dr. Satya Prakash, *Chemistry Department, University of Allahabad, Allahabad.*

Geology & Geography—Dr. R. N. Dube, *Geography Department, University of Allahabad, Allahabad.*

Botany—Dr. R. N. Suksena, *Botany Department, University of Allahabad, Allahabad.*

Zoology & Entomology—Mr. S. C. Verma, *Zoology Department, University of Allahabad, Allahabad.*

Anthropology & Archaeology—Mr. S. C. Kala, *Curator, Allahabad Municipal Museum, Allahabad.*

Medical N *Veterinary Sciences*—Dr. P. Ghosh, *Medical Officer, University of Allahabad, Allahabad.*

Agricultural Sciences—Dr. T. A. Mosher, *Principal, Agricultural College, Allakabad.*

Physiology—Dr. K. D. Vyas, *Zoology DePartment, University of Allahabad, Allahabad.*

Psychology N *Educational Sciences*—Dr. Lt. Col. Sohan Lall,

Engineering & Metallurgy—Mr. D. H. R. Rao, *Engineer, University of Allahabad, Allahabad.*

SECTIONAL COMMITTEES.

(Names marked with * indicate that they were also Recorders of the respective Sections)

1. Mathematics—

Dr. S. Chowla	*Convener.*
Prof. P. N. Das Gupta	*Recorder.*
Mr. U. R. Burman	*Sectional Correspondent.*
Dr. P. L. Shrivastava	*Local Sectional Secretary.*
Dr. Nalini Mohan Basu Dr. B. R. Seth	*Elected Members.*
Prof. N. R. Sen Prof. A. C. Banerji *Prof. M. R. Siddiqi Mr. B. M. Sen *Dr. B. N. Prasad *Dr. Ram Behari Dr. D. D. Kosambi	*Past Presidents who are either Ordinary or Honorary Members*
Mr. S. Gupta Dr. S. Ghosh Dr. N. G. Shabde Prof. B. B. Sen	*Past Recorders who are either Ordinary or Honorary Members*

2. Statistics—

*Dr. U. S. Nair	*Convener.*
Shree Sadashiv Sen Gupta	*Recorder.*
Mr. H. K. Nandi	*Sectional Correspondent.*
Mr. J. K. Mehta	*Local Sectional Secretary.*
Mrs. Chameli Bose Dr. P. V. Sukhatme	*Elected Members.*
Prof. P. C. Mahalanobis	*Past President of the Mathematics and Statistics Section.*
Prof. K. B. Madhava Mr. R. C. Bose *Mr. S. N. Roy	*Past Presidents of Statistics Section.*
Dr. C. Chandra Sekar *Dr. P. K. Bose	*Past Recorder of the Statistics Section.*

3. Physics—

Dr. R. S. Krishnan	*Convener.*
Dr. P. S. Gill	*Recorder.*
Dr. S. D. Chatterjee	*Sectional Correspondent.*
Dr. R. N. Ghosh	*Local Sectional Secretary.*
Dr. N. K. Saha Mr. R. N. Rai	*Elected Members.*

Sir C. V. Raman .. ..
Mr. T. P. Bhaskara Shastri ..
Dr. S. K. Banerji .. ..
Prof. M. N. Saha .. ..
Dr. D. M. Bose .. ..
Prof. S. N. Bose .. ..
Prof. B. Venkatesachar ..
Prof. S. K. Mitra .. ..
Dr. A. L. Narayan .. ..
*Dr. S. Datta .. ..
Diwan Bahadur K. R. Ramanathan
Sir K. S. Krishnan .. ..
Prof. H. J. Bhabha .. ..
*Prof. D. S. Kothari .. ..
*Dr. R. C. Majumdar ..
Prof. S. Bhagavantam ..
Prof. K. Banerjee .. ..
Dr. L. A. Ramdas .. ..

Past Presidents who are either Ordinary or Honorary Members.

Prof. G. R. Paranjpe ..
Prof. H. Parameswaran ..
Dr. R. K. Asundi .. ..
Dr. D. V. Gogate .. ..
Dr. N. R. Tawde .. ..
Dr. A. K. Dutta .. ..

Past Recorders who are either Ordinary or Honorary Members.

4. Chemistry—

Dr. P. B. Ganguly .. .. *Convener.*

Dr. Dukhaharan Charavarti .. *Recorder.*

Dr. T. N. Ghosh .. .. *Sectional Correspondent.*

Dr. Satya Prakash .. .. *Local Sectional Secretary.*

Dr. S. Roy .. ..
Dr. Narendra Nath Ghatak ..

Elected Members.

Prof. J. L. Simonsen ..
Dr. G. J. Fowler .. ..
Prof. B. K. Singh .. ..
Sir J. C. Ghosh .. ..
Prof. B. B. Dey .. ..
Sir S. S. Bhatnagar .. ..
Prof. J. N. Mukherjee ..
Prof. P. C. Mitter .. ..
Dr. K. G. Naik .. ..
Prof. P. Ray .. ..
*Prof. P. Neogi .. ..
*Prof. P. C. Guha .. ..
*Dr. J. N. Ray .. ..
Dr. P. B. Sarkar .. ..
Dr. S. Krishna .. ..

Past Presidents who are either Ordinary or Honorary Members.

*Prof. Mata Prasad	
*Prof. S. S. Joshi	
*Prof. R. C. Ray	
*Prof. K. Venkataraman ..	
Dr. B. C. Guha	
Dr. P. K. Bose	
Prof. B. Sanjiva Rao ..	
Prof. D. D. Karve	*Past Recorders who are either Ordinary or Honorary Members.*
Dr. S. N. Mukherjee ..	
Dr. S. Siddiqui	
Prof. J. K. Chowdhury ..	
Dr. U. P. Basu	

Geology and Geography—

Dr. C. Mahadevan	*Convener.*
Dr. S. C. Chatterjee	*Recorder.*
Mr. Subodh Ch. Bose ..	*Sectional Correspondent.*
Dr. R. N. Dube	*Local Sectional Secretary*
Dr. S. Deb	*Elected Members.*
Mr. K. Bagchi	
Mr. E. S. Pinfold	*Past Presidents who are either Ordinary or Honorary Members.*
Sir L. L. Fermor	
Dr. D. N. Wadia	
Prof. B. Sahni	
Mr. P. Evans	
*Dr. M. S. Krishnan.. ..	
Dr. B. Rama Rao	
Dr. W. D. West	
*Prof. L. Rama Rao	
Dr. M. R. Sahni	
Dr. Rajnath	
*Dr. Shibaprasad Chatterjee	
Dr. S. M. Tahir Rizvi ..	
*Dr. A. S. Kalapesi	
*Mr. N. N. Chatterjee ..	
*Dr. C. S. Pichamuthu ..	
Dr. P. K. Ghosh	
Mr. V. P. Sondhi	*Past Recorder who are either Ordinary or Honorary Members.*
Prof. Maneck B. Pithawalla ..	
Mr. A. K. Banerjee .. .	
Prof. Nafis Ahmed	
Dr. B. N. Mukerji .. .	
Mr. L. S. Krishna Murthy ..	
Mr. T. N. Muthuswami ..	

Botany—

Mr. M. S. Randhwa ..	..	*Convener.*
Dr. R. L. Nirula ..	..	*Recorder.*
Mr. A. K. Ghosh ..	..	*Sectional Correspondent.*
Dr. R. K. Saksena ..	..	*Local Sectional Secretary*
Dr. B. K. Kar .. Prof. Panchanan Maheswarc ..	.... ..	*Elected Members.*
Prof. B. Sahni .. Prof. S. P. Agharkar Prof. M. O. P. Iyengar Prof. K. C. Mehta .. Prof.P. Parija .. Prof. R. H. Dastur .. *Dr. S. R. Bose .. *Dr. Krishnadas Bagchee *Prof. Y. Bharadwaja *Dr. Shri Ranjan .. Dr. N. L. Bor .. Dr. K. Biswas .. Dr. T. S. Sabnis .. *Dr. G. P. Majumdar .. Dr. B. P. Pal .. Prof. A. C. Joshi .. Dr. K. A. Chaudhury	.. ..	*Past Presidents who are either Ordinary or Honorary Members.*
Prof. S. L. Ajrekar .. Prof. M. Sayeed-ud-Din Prof. F. R. Bharucha Dr. P. Anand .. Mr. N. K. Tiwary .. Dr. S. N. Das Gupta Prof. J. C. Sen-Gupta Dr. T. S. Mahabale .. Dr. P. K. Sen .. Dr. B. C. Kundu .. Dr. S. Ramananujam	.. ..	*Past Recorder who are either Ordinary or Honorary Members.*

Zoology and Entomology—

Dr. M. L. Roonwal ..	..	*Convener.*
Dr. H. D. Srivastava	..	*Recorder.*
Mr. J. N. Rudra ..	..	*Sectional Correspondent.*
Mr. S. C. Verma ..	..	*Local Sectional Secretary.*
Dr. S. N. Ghosh .. Dr. B. C. Basu ..	.. ..	*Elected Members.*

Prof. K. N. Bahl ..	..	*Past Presidents who are either Ordinary or Honorary Members.*
Dr. B. Prasad ..	..	
Dr. H. R. Mehra ..	..	
*Dr. B. Sundara Raj ..	..	
Dr. S. L. Hora ..	..	
Prof. D. R. Bhattacharyya	..	
Prof. R. Gopala Aiyar	..	
Diwan Anand Kumar	..	
Prof. H. K. Mookerjee	..	
Dr. G. S. Thapar ..	..	
Prof. B. K. Das ..	..	
Prof. A. Subba Rau ..	..	
Prof. M. Afzal Husain	..	
Rao Bahadur Y. Ramchandra Rao		
Dr. B. N. Chopra ..	..	
Prof. Vishwa Nath ..	..	
Mr. D. Mukerji ..	..	
Dr. H. N. Ray ..	..	
Dr. M. A. Moghe ..	..	
Dr. G. D. Bhalerao ..	..	
*Prof. A. B. Misra ..	..	
Prof. S. G. M. Ramanujam	..	*Past Recorders who are either Ordinary or Honorary Members.*
Mr. G. K. Chakravarty	..	
Mr. Beni Charan Mahendra	..	
Dr. J. L. Bhaduri ..	..	
Dr. B. R. Seshachar ..	..	
Mr. M. M. Chakravarty	..	
Dr. P. Sen ..	..	
Dr. K. B. Lal ..	..	
Dr. M. L. Bhatia ..	..	
Mr. D. Ganguli ..	..	
Dr. D. V. Bal ..	..	

8. Anthropology and Archaeology—

Prof. Nirmal Kumar Bose	..	*Convener.*
Mr. M. N. Basu ..	..	*Recorder.*
Mr. S. S. Sarkar ..	..	*Sectional Correspondent.*
Mr. S. C. Kala ..	..	*Local Sectional Secretary.*
Mr. Satyendra Prasad Roy	..	*Elected Members.*
Mr. Anil Chowdhury	..	
Prof. P. C. Mahalanobis	..	*Past Presidents who are either Ordinary or Honorary Members.*
Dr. J. H. Hutton ..	..	
Dr. B. S. Guha ..	..	
Prof. K. P. Chattopadhyay	..	
Dr. G. S. Ghurye ..	..	
*Dr. D. N. Majumdar	..	
*Mr. T. C. Das	..	
Dr. M. H. Krishna ..	..	
Dr. N. P. Chakravarti	..	
* Dr. A. Aiyappan ..	..	
*Dr. (Mrs.) Irawati Karve	..	
Mr. A. Chatterjee ..	..	

Dr. G. M. Kurulkar .. .. Past Recorders who are either Ordinary or Honorary Members.
Capt. R. N. Basu .. ..
Mr. T. C. Roy Chowdhuri ..
Mr. D. Sen .. ..
Dr. J. K. Bose .. ..
Dr. N. Datta-Majumdar ..
Dr. H. D. Sankalia ..
Dr. P. C. Biswas .. ..

9. **Medical and Veterinary Sciences—**

*Dr. M. B. Sobarwar .. *Convener.*
Dr. Harendra Nath Ray .. *Recorder.*
Dr. D. Pauja .. .. *Sectional Correspondent.*
Dr. P. Ghosh .. .. *Local Sectional Secretary.*

Dr. A. K. Bose .. .. *Elected Members.*
Dr. J. C. Ray . ..

Sir R. N. Chopra . .. *Past Presidents who are either Ordinary or Honorary Members.*
Lt.-Col. S. S. Sokhey .
*Mr. A. C. Ukil .. ..
*Dr. C. G. Pandit .. ..
Prof. K. V. Krishnan ..
Dr. S. W. Hardikar .. .
RaiBahadur K. N. Bagchi ..
*Prof. G. Panja .. ..
*Dr. G. D. Bhalerao .. ..

*Dr. Phanindranath Brahmachari *Past Recorders who are either Ordinary or Honorary Members.*
Mr. M. R. Mahajan .. ..
Prof. G. Sankaran .. ..
Mr. D. V. S. Reddy .. ..
Dr. M. V. Radhakrishna Rao ..
Dr. S. K. Basu .. ..

10. **Agricultural Sciences—**

Dr. R. S. Vasudeva .. .. *Convener.*
Mr. P. C. Rakeja .. .. *Recorder.*
Mr. E. A. R. Banerjee .. *Sectional Correspondent.*
Dr. T. A. Mosher .. .. *Local Sectional Secretary.*

Dr. J. S. Patel .. .. *Elected Members.*
Dr. S. C. Roy .. ..

Sir T. S. Venkataraman .. *Past Presidents who are either Ordinary or Honorary Members.*
Sir T. Vijayaraghavacharya ..
Prof. M. Afzal Hussain ..
Mr. A. K. Y. Narayan Aiyer ..
Dr. B. Viswanath .. ..
Rao Sahib T. V. Ramakrishna Ayyar
Prof. Jai Chand Luthra ..
Mr. K. Ramiah .. ..
Rao Bahadur Y. Ramchandra Rao
Dr. D. V. Bal .. ..

Prof. N. V. Joshi	..	
Rao Bahadur Y. Ramanatha Ayyar	..	
Mr. N. L. Dutt	..	
Rai Bahadur Kalidas Sawhney	..	
Dr. S. V. Desai	..	*Past Recorders who are either Ordinary or Honorary Members.*
Dr. A. N. Puri	..	
Dr. C. N. Acharya	..	
Dr. J. K. Basu	..	
Dr. T. V. Sukhatme	..	
Dr. B. L. Chona	..	
Dr. S. P. Ray Chaudhuri	..	

11. **Physiology** —

Prof. B. B. Sarkar	..	*Convener.*
Prof. N. P. Benawari	..	*Recorder.*
Dr. N. N. Das	..	*Sectional Correspondent.*
Dr. K. D. Vyas	..	*Local Sectional Secretary.*
Dr. Sachidananda Banerjee	..	*Elected Members.*
Prof. S. K. Sen	..	
Prof. W. Burridge	..	*Past Presidents who are either Ordinary or Honorary Members.*
Lt. Col. S. L. Bhatia	..	
Sir R. N. Chopra	..	
*Prof. N. M. Basu	..	
*Dr. B. B. Dikshit	..	
Rao Bahadur B. T. Krishnan	..	
Prof. B. Narayana	..	
*Prof. S. N. Mathur	..	
*Dr. B. Mukerji	..	
Prof. P. De	..	
*Prof .S. A. Rahman	..	
*Dr. Bashir Ahmad	..	
Mr. K. Mitra	..	*Past Recorders who are either Ordinary or Honorary Members.*
K. P. Basu	..	
Mr. B. Chatterji	..	
Prof. Khem Singh Grewal	..	
Mr. M. L. Chatterjee	..	
Prof. G. K. Ghosh	..	
Mrs. Kamala Sawhney	..	

. **Psychology and Educational Science** —

*Prof. T. K. N. Menon	..	*Convener.*
Prof. Kali Prasad	..	*Recorder.*
Mrs. Santa Deb	..	*Sectional Correspondent.*
Dr. (Lt. Col.) Sohan Lall	..	*Local Sectional Secretary.*
Mrs. Mamata Chowdhury	..	*Elected Members.*
Mrs. Bani Chatterjee	..	

Prof. H. Bhattacharya ..
Mr. N. S. N. Sastry .. ..
Prof. G. S. Bose .. ..
Dr. S. C. Mitra .. .
Mr. J. M. Sen . ..
Mr. K. C. Mukherji .. ..
Prof. H. P. Maiti .. ..
Dr. I. Latif . ..
*Dr. G. Pal .. ..
*Prof. B. L. Atreya .. ..
*Dr. B. Kupuswamy .. ..
*Dr. Indra Sen .. ..
Mr. P. S. Naidu .. ..
Dr. Zahar Husain .. ..

} *Past Presidents who are either Ordinary or Honorary Members.*

Mr. S. K. Bose .. ..
Mr. S. Sinha .. ..
Mr. Pars Ram .. ..
Dr. (Miss) K. H. Cama ..

} *Past Recorders who are either Ordinary Honorary Members.*

3. **Engineering and Metallurgy—**

Prof. M. Sen Gupta .. .. *Convener.*
Mr. J. Ganguly .. .. *Recorder.*
Dr. J. N. Basu .. .. *Sectional Correspondent.*
Mr. D. H. R. Rao .. .. *Local Sectional Secretary.*

J. Dutta Esqr. .. ....
Dr. D. R. Malhotra ..

} *Elected Members.*

*Dr. A. H. Pandya .. ..
Mr. N. V. Modak .. ..
Sir Jehangir Ghandy ..
Rai Bahadur A. N. Khosla ..
Mr. P. H. Kutar .. ..
Mr. H. P. Bhaumik .. ..
*Mr. N. Sen .. ..

} *Past Presidents who are either Ordinary or Honorary Members.*

Prof. H. L. Roy .. ..
Dr. S. K. Sircar .. ..

} *Past Recorders who are either Ordinary or Honorary Members.*

Sub-Committee on Science and its Social Relations:—

1-4. President, two General Secretaries and Treasurer (*ex-officio*).
1-17. Sectional Presidents of 13 Sections.
18. Dr. S. P. Agharkar (Bombay).
19. Dr. K. N. Bagchi (Calcutta).
20. Prof. H. J. Bhabha (Bombay).
21. Dr. G. D. Bhalerae (Izatnagar).
22. Dr. Gellert J. Yowber (Bangalore).
23. Dr. B. C. Guha (Calcutta).
24. Prof. D. D. Kanga (Adyar).
25. Prof. H. P. Maiti (Patna).
27. Dr. K. Matwani (Adyar).
26. Dr. H. K. Mitra (Jamshedpur).
28. Prof. M. N. Saha (Calcutta).
29. Prof. Beney Kumar Sarkar (Calcutta).
30. Rai Bahadur K. D. Sawhney (Hyderabad).
31. Rai Bahadur J. M. Sen (Calcutta), Convener.
32. Sir S. S. Sakhey (Bombay).
33. Dr. A. C. Ukil (Calcutta).
34. Dr. D. N. Wadia (New Delhi).

LIST OF MEMBERS

HONORARY MEMBERS

BEAUFORT, L. F. De, Director, Zollogical Institute, Amsterdam, Holland.
HILL, A. V., F.R.S., 16, Bishop Wood Road, Highgate, London, N 6.
JUNG, C. G., Professor of Psychology, University of Zurch, Switzerland.
RAMAN, Sir C. V., Kt., F.R.S., Nobel Laureate, Iindian Institute of Science, P.O Malleswaram, Bangalore.
SAHA, M. N., D.Sc., F.R.S., F.R.AS.B.. F.N.I., Palit Professor of Physics, University College of Science, 92, Upper Circular Road, Calcutta.
SIMONSEN, John Lionel, D.Sc., F.R.S., Director, Colonial Products Research, Imperial Institute, South Kensington, London, S.W. 7.
VISVESVARAYA, Sir M., K.C.I.E., Uplands, High Ground, Bangalore.

BENEFACTORS

Burmah Oil Co., (India Trading), Ltd., Digboi, Assam.
Ghadialy, Pestonji, F., F.R.G.S., F.R.S.A., F.B.H.I., (Lond.), M.M.E,A., A.M.A.F., M.I.S.E., Senior Scientific Officer Engineering Intelligence Service, Delhi
Tata Iron & Steel Co., Ltd., 'Bombay House', Bruce Street, Fort, Bombay.

ORDINARY MEMBERS

[As at the close of July 15, 1948 (Rule 4). The names of Sustaining Members are marked with † and the names of Life Members are marked with.]*

A

ACHAN, P. Anujan, Government Archaelogist, Cochin State, Trichur.
ACHARYA, C. N., M.Sc., Ph.D., D.Sc., F.R.I.C., Department of Agriculture, Government of India, New Delhi.
ADARSHVADI, D. P., R. E. (Pb.), Grad. I.R.T.T., P.O. Box No. 111,* Faiz Bazar, Delhi.
ADHIKARI, N., Assistant Manager (Chemicals), Bengal Chemical & Pharmaceutional Works Ltd., 164, Maniktala Main Road, Calcutta.
ADHYA, G. M., B.Sc., E.E. (Wis, U.S.A.). Grad. G. E. Tech. (Maso) A.M.A.E, Chief Engineer, Hastings Mill Ltd., Rishra, Hoogly.
AGARWAL, Har Narain, Banker, Landlord and Mills Owner, Lakhrajnagar, Aligarh.
AGARWAL, P. P., I.C.S., Secretary to Government, Finance Dept., Patna.
AGARWALA, P. M., Director, Post and Telegraphs, Construction Branch, New Delhi.
†AGHARKAR, S. P., M.A. (Bom.), PhD., (Berlin), F.L.S., F.N.I., 18, Godavari Chal. Shastri, Hall, Grant Road, Bombay 7.
AGRWAL, Y. K., Lecturer in Geology, Indian School of Mines, Dhanbad.
AHMAD, B., Ph.D., (Lond.), Director, Punjab University Institute of Chemistry, The Mall, Lahore.
AHMAD, KAZI S., M.A., Ph.D., Head of the Geography Dept., Punjab University, Lahore.
*AHMED, Khwaja Mohammed, Director of Archaeology, Hyderabad-Deccan.
AHMAD, Nazir M.Sc, (Hons.), Ph.D., F..Z.S. Director of Fisheries, East Bengal, Comilla,
AHMED, Nafis, M.A., Professor of Geography, Department of Geography, University of Dacca, P.O. Raming, Dacca, East Bengal.

AIYA, S. V. Chandrasekhar, M.A., (Cantab), B.Sc., A.M.I.E.E., S.M.I.R.E., Professor of Electrical Communication, College of Engineering, Poona 5.

AIYAR, R. Gopala, M.A., M.Sc., Professor of Zoology and Honorary Director, Madras University, Zoological Laboratory, Triplicane P.O., Madras.

AIYAR, T. V. Ramachandra, B.A., F.R.Met.S., Meteorologist to the Government of Mysore, Central Observatory, Bangalore.

AJREKAR, S. L., F.N.I., I.E.S. (retd.), 855, Shivajinagar, Bhandarkar Institute Road, P.O. Deccan Gymkhana, Poona 4.

ALASAGRACHAR, R. A., B.E. (Retd.), Mechanical Engineer, Inspector of Factories, Department of Industries, Nagpur.

ALEMBIC Chemical Works Co., Ltd., Baroda.

ALI, Syed Bashir, M.Sc., Lecturer in Chemistry, Muslim University, Aligarh.

ALIKUNHI, K. H., M.Sc., Asst. Director of Fisheries, Fresh Water Biological Station, Kilpauk, Madras.

ALIMCHANDANI, Rupchand Lilaram, M.Sc., Professor and Head of the Department of Chemistry, Karnatak College, Dharwar, M. S. M. Ry.

AMIN, D. L., Asst. Professor of Logic and Psychology J. J. College of Science, Nadiad, Bombay Presidency.

AMIN, Indubhai, Technical Advisur, Alembic Chemical Works Ltd.,

AMIN, Manibhai Bhailalbhai, Managing Director The Sanitex Chemical Industries Ltd., Boroda.

AMRITSAR Sugar Mills Ltd., Rahana Kalan, N. W. Ry., P.O. Rahana Mill, Muzaffarnagar.

APPAJEE, Y., B.A., M.B.B.S., M.Sc. (Lond.), Professor of Anatomy, Medical College, Mysore.

ARNIKAR, H. J., Dept., of Chemistry, College of Science, Benares Hindu University, Benares.

ARORA, Srinath Das, M.Sc., L.T., Professor of Chemistry, Jaswant College, Sardarpura, Jodhpur.

ASOLKAR, G. V., M.Sc., Lecturer, College of Science, Nagpur.

ASUNDI, R. K., B.A. (Hons.), M.Sc. (Bom.), Ph.D. (Lond.), Professor of Physics, Benares, Hindu University, Benares.

ATHAVALE, V. B., M.Sc., F.R.G.S. Professor H. P. T. College, Nasik, Bombay Presidency.

ATREYA, B. L., M.A., D.Litt., University Professor and Head of the Department of Philosophy, Benares Hindu University, Benares.

AULUCE, Faqur Chand, Lecturer in Mathematics, Delhi University, Delhi.

AYER, A. Ananthanarayana, B.A., M.B.B.S., Additional Professor of Anatomy, Central Institute of Anatomy and Physiology, Medical College, Madras.

AYYAR, C. V. Subbarama, M.A., Professor of Mathematics, University College, Trivandrum.

AYYAR, P. Ramaswami, 'Veda Nivas', Malleswaram P.O., Bangalore.

AYYAR, S. N. Venkatarama, Post Box. 412, Triplicane P.O., Madras.

AYYAR, T. V. Ramakrishna, Rao Sahib, B.A., Ph.D., F.Z.S., Girija' Farm, Mundu P.O. Via Olavakot, Malabar, S. India.

B

BADAMI, B. K., Director, Veterinary Department, H. E. H. the Nizam's Government. Hyderabad-Deccan.

BADAMI, Rajasekhar C., Department of Chemistry, Karnatak College, Dharwar.

BAGCHEE, Krishnadas, D.Sc. (Lond.), D.I.C., F.N.I., Mycologist, Forest Research Institute and College, New Forest P.O., Dehra Dun.

BAGCHI, Kanangopal, M.Sc., Asstt. Lecturer, Department of Geography, Senate House, Calcutta.

BAGCHI, K. N., Rai Bahadur, B.Sc., M.B. (Cal.), F.I.C. (Lond.), D.T.M. (Cal. & Lopool), Late Chemical Examiner to the Government of Bengal, 5, Ballygunge Place, Calcutta.

BAHL, K. N., D.Sc., (Panj.), D.Phil., D.Sc., (Oxon.), F.R.A.S.B., F.N.I., Professor of Zoology, Lucknow University, Lucknow.

BAL, Chandra, Major, M.Sc., Professor of Zoology, Benares Hindu University, Benares.

BAL, D. V., Rao Bahadur, M.Sc. (Agri.) (Hons.), Ph.D., A.I.C., Agricultural Chemist to the Government of Central Province and Bearar, Nagpur, C. P.

BAL, D. V., M.Sc., Ph.D. (L'pool), F.A.Sc., Professor of Zoology, Royal Institute of Science, Mayo Road, Bombay 1.

BALAKRISHNAN, S., Managing Director, Foto Products Limited, P.O. Box No. 49, Bombay.

BALANCE Works, The D30|32, Deonathpura, Benares

BANDUKWALA, Kalimuddin T., L.T.C., Ph.D., Manager, Bombay Soap Factory, Ripon. Road Cross Lane, Madanpura, Bombay 8.

BANDYOPADHYAY, Gaganbehari, M.Sc., Dept. of Applied Mathematics, University College of Science, 92, Upper Circular Road, Calcutta 9.

BANERJEE, Ajit Kumar, Lecturer, Teachers' Training Department, Calcutta University, Calcutta.

BANERJEE, A. N., M.Sc., Research Assistant, Bose Research Institute, 93, Upper Circular Road, Calcutta 9.

BANERJEE, Basudeb, B.Sc. (Cal.), Dr. Phil, (Munich), Sir J. C. Bose Fellow, Calcutta University, Bose Institute, 93, Upper Circular Road, Calcutta 9.

BANERJEE, Benoyendra, M.A., Secretary, Public Service Commission, W. B., Anderson House, Alipore.

BANERJEE, Bhupati Kumar, M.Sc., Research Works, Indian Association for the Cultivation of Science 210, Bowbazar Street, Calcutta.

BANERJEE, B. N., Department of Biochemistry, Indian Institute of Science, P.O. Malleswaram, Bangalore.

BANERJEE, E. A. R., M.Sc., Dip. Agri., Economic Botanist to the Govt. of West Bengal, Govt. Agricultural Farm, Chinsurah (Dist. Hooghly).

BANERJEE, G. M.Sc., Asstt. Secretary, Indian Chemical Society, University College of Science, 92, Upper Circular Road, Calcutta.

BANERJEE, G. N., B.Sc., F.R.M.S., M.Mic. Soc., P.O. Box. 5576, Bombay 14.

BANERJEE, Jogesh Chandra, M.B., M.R.C.P. (Lond.), M.R.C.S. (Eng.), Medical Practitioner, 67, Dhurrumtollah Street, Calcutta.

BANERJEE, K., D.Sc., F.N.I., Mahendralal Sircar Professor of Physics, Indian Association for the Cultivation of Science, 210 Bowbazar Street, Calcutta.

BANERJEE, Pinakilal, P.O. Ariadah, Dakshineswar, 24-Parganas.

BANERJEE, Prasadkumar, Statistical Laboratory, Presidency College, Calcutta.

BANERJEE, S., Mechanical Engineer, 1|1D, Nayaratna Lane, Shambazar, Calcutta.

BANERJEE, S. K., D.Sc. (Cal.), Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

* BANERJEE, Sachchidananda, M.Sc., M.B., D.Sc. (Cal.), M.A.D.A. (U.S.A.), P52, Butto Krishto Paul, Avenue, Flat 2C & 2D, Calcutta.

BANERJEE, S. S., D.Sc., F.I.P.S., M.I.R.E., Assistant Professor of Communication Engineering and Applied Physics, Engineering College, Benares Hindu University, Benares.

BANERJEE, T., M.Sc. (Cal.), Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

BANERJEE, Tarapada, D.Sc. (Dacca), Lecturer in Chemistry, Dacca Univerisity, Ramna, P.O., Dacca.

BANERJI, A. C., M.A. (Cantab), M.Sc., F.R.A.S., F.N.I. I.E.S. (Retd.) Professor of Mathematics, University of Allahabad, Allahabad.

BANERJI, I., D.Sc., F.N.I., F.L.S., University Lecturer in Botany, University College of Science, 35, Ballygunge Circular Road, Calcutta.

BANERJI, J., I.F.S., Shri, Project officer, Soil Conservation and Afforestation, Govt. of India, Central Waterways, Irrigation and Navigation Commission, Curzon Road, New Delhi.

BANERJI, Nabajiban, M.B., Director, Calcutta Clinical Research Association, 91, Theatre 10, Rowdon Street, Calcutta.

BANERJI, S. M., M.Sc., M.B., Professor of Physiology, Orissa Medical College, Cuttack.

BANERJI, Sudhansu Kumar, O.B.E., D.Sc., F.N.I., Director-General of Observatories, Upper Air Office, Lodi Road, New Delhi.

BAPAT, S. V., M.Sc., C/o. Dr. D. V. Bal, Hony. Prof. of Zoology, Royal Institute of Science, Bombay 1.

BARAL, H. C., Chief Transportation Superintendent, Superintendent's Office, G. I. P. Rly., Bombay, V. T.

BARAT, C., M.Sc., Dr. Ing., A.R.I.C., Technical Director, Calcutta Industrial Chemicals and Minerals Co., Ltd., 4, Earle Street, P.O. Kalighat, Calcutta 26.

BARAVE, Raghunath Vinayak, M.Sc., Professor of Physics, Willingdon College, Satara, Bombay.

BARDHAN, Leiut. Col. P. N., I.A.M.C., L.M.S. (Singapur), F.R.C.P. (Edin.), D.P.H. (Eng.), M.M.S.A., D.R.C.O.G., Adviser in Pathology, Southern Command, C|o. Command Pathology Laboratory, South, Bangalore.

BARIA, (Mrs) D. D. H., M.Sc., 'Panorama', 203, Walkeshwar Road, Malabar Hill, Bombay 6.

BARMAN, J. N., M.Sc., A.R.I.C., M.M.G.C., Chelidanga, Asansol.

BARVE, P. M., M.Sc., Dept. of Chemistry, Wilson College, Bombay 7.

BASAK, K. C., B.A., Director of Economic Research, Indian Central Jute Committee, 4, Hastings Street, Calcutta.

BASAK, Manindra Nath, M.B., D.T.M., Medical Practitioner, 15, Anukul Mukherji Road, Calcutta.

*BASU, Anath Nath, M.A., (Lond.), T.D. (Lond.), Head of the Teachers' Training Dept., Calcutta University, Asutosh Building, Calcutta.

BASU, B. C., D.Sc., Writer Biology, Entomologist, Imperial Viterinary Research Institute, P.O. Izatnagar, Bareilly.

BASU, Charu Chandra, B.A., M.B., Professor of Pathology, Carmichael Medical College, Calcutta.

BASU, Durgadas, M.A., Statistical Officer, Department of Agriculture, Government of Bengal, Bengal Agricultural Institute, Writers Building Calcutta.

BASU, J. K., M.Sc, (Cal.), Ph.D. (Lond.), F.N.I., Soil Physicist to Government, B. P. Sholapur.

BASU, J. N., M.I.E., M.A.E., Dr. Eng., Professor of Mechanical Engineering, College of Engineering and Technology, P.O. Jadavpur College, 24-Parganas.

BASU, K. P., D.Sc., Ph.D., Dairy Chemist, Indian Dairy Rech. Institute, Bangalore.

BASU, Minendra Nath, M.Sc., Lecturer in Anthropology, University College of Science 35, Ballygunge Circular Road, Calcutta.

BASU, Nalini Mohan, D.Sc., Professor of Mathematics and Head of the Depart, University of Dacca, Dacca.

BASU, Narendra Mohan, M.A., Senior Professor of Physiology, Presidency College Calcutta.

BASU, R. N., M.Sc., Capt., I.M.S., 7A, Nafar Kundu Road, P.O. Kalighat, Calcutta.

BASU, S., M.Sc., Superintending Meteorologist, Meteorological Office, Ganesh-khind Road Poona 5.

BASU, Saradindu Ranjan, M.Sc., Vice-Principal, Teachers' Training College, Corporation of Calcutta, Calcutta.

BASU, Satyendra Prasanna, M.Sc., B.F.S., 44, Girish Mukherjee Road, Bhowanipur Calcutta.

BASU, Sushil Kumar, M.Sc., M.B., D.T.M., D.P.H., Ph.D., (Edin.), 39, Narkeldanga Main Road, Calcutta.

BASU, U. P., D.Sc., P.R.S., F.N.I., 98-4, Surendra Nath Banerjee Road, P.O. Entally, Calcutta 14.

BEHARI, Ram, M.A. (App. Maths.), M.A. (Pure Maths.) (Panj.), M.A. (Cantab), Ph.D., Sc.D. (Dublin), F.N.I., Head of the Dept. of Mathematics, Delhi University, St. Stephen's College, Delhi.

BENAWRI, N. P., Ph.D., Prof. of Physiology, Darbhanga Medical College, Laheria Sarai P.O., O. T. Rly. (Bihar).

BERA, G. N., M.Sc., Dept. of Physiology, Presidency College, Calcutta.

BHABHA, H. J., B.A., Ph.D. (Cantab.), F.R.S., Tata Institute of Fundament Research, 53, Pedder Road, Bombay 26.

BHADURI, Baidya Nath, M.B., Visiting Opthalmic Surgeon, Carmichael Medical College Hospital, Calcutta.

BHADURI, J. L., Zoological Laboratory, University College of Science, 35, Ballygunge Circular Road, Calcutta.

BHADURI, Manindra Bhusan, B.L., P.O. Khunti, Dist. Ranchi.

BHAGAT, M. G., M.A., B.Sc., Ceramic Engineer, 45, Tangra Road, Calcutta.

BHAGAVANTAM, S., D.Sc., Professor of Physics, Andhra University, Waltair.

BHAGWAT, W. V., D.Sc., F.A.Sc., Head of the Chemistry Dept., Holkar College, Indore.

BHALERAO, G. D., D.Sc., Ph.D. (Fac. Med. Lond.), F.Z.S., F.R.M.S,, F,A,Sc,, Director, Indian Veterinary Research Institute, Izatnagar.

BHANDARI, D. M., Development Minister, Jaipur State, Jaipur.

BHANDARI, Narendra Nath, B.A., D.I.C., Ph.D. (Lond), Assistant Secretary, Central Board of Irrigation, Kennedy House, Simla, S. W.

BHARADWAJA, Yajnavalkya, M.Sc., (Panj.), Ph.D. (Lond.), F.L.S., F.N.I., University Professor and Head of the Department of Botany, Benares Hindu University, Benares.

BHARDWAJ, D. C., M.Sc., Institute of Palaeobotany, Dept. of Botany, The University, Lucknow.

BHARGAVA, P. M., M.Sc., (Lucknow), Society Park, Narhi, Lucknow.

BHATIA, M. L., M.Sc., Ph.D., D.Sc., Dept. of Zoology, University of Delhi, Delhi.

BHATIA, Sohan Lal, C.I.E., M.C., M.A., M.D., B.Ch. (Cantab), F.R.C.P. (Lond,), F.R.S.E., Col., Surgeon-General with the Government of Madras, Madras 6.

*BHATNAGAR, Sir Shanti Swarup, Kt., O.B.E., D.Sc., F.R.S., F.Inst.P., F.I.C., F.S.C.I. (Hons.), F.N.I., Directors, of Scientific and Industrial Research, Government of India, University Buildings, Delhi

BHATT, L. A., M.Sc., Ph.D., (Lond.), Kilachand Devchand and Co., Ltd., 45-47, Apollo Street, Fort, Bombay.

BHATT, L. J., Juna Modikhana, Baroda.

BHATT, U. J., State Engineer, Bhavnagar State, Hill Drive, P.O. Bhavnagar, Kathiawar.

BHATTACHARYA, Ardhendu Sekhar, M.Sc., Sri Arabinda Asram, Pondicherry.

BHATTACHARYA, B. C., M.Sc., Teach. (Manch.), B.Sc. (Cal.), A.M.C.T., A.T.I., Principal, Bengal Textile Institute, Serampore.

* BHATTACHARYA, Biswa Nath, M.Sc., Asst. Professor of Biology, C. & S. College, Shikarpur, (Sind).

BHATTACHARYA, B. K., Prof. of Organic Chemistry, Jadavpur College of Engineering & Technology, P.O. Jadavpur College, 24-Parganas..

BHATTACHARYA, D. R., M.Sc., Ph.D. (Dublin), Docteur-es-Sciences (Paris), F.N.I., Professor of Zoology, Allahabad University, Allahabad.

BHATTACHARYA, G., M.Sc., Manager, Messrs. Adair Dutt & Co, Ltd., 5, Dalhousie Square East, Calcutta.

BHATTACHARYA, Jayanta Kumar, B.Sc., M.B., D.P.H. (Cal.), M.P.H., Singur Health Centre, P.O. Singur, Hooghly, West Bengal.

BHATTACHARYA, Punyabrata, M.Sc., Ph.D., Research Officer, (Artificial Insemination), Indian Veterinary Research Institute, Izatnagar (U. P.).

BHATTACHARYYA, H., B.A., (Cal.), F.R.E.S. (Lond.), F.S.T.A. (Ind.), Industrial Surveyor, Directorate of Industries, Government of West Bengal, 11|B, Fern Road, Ballygunge, Calcutta 19.

BHAUMIK, H. P., O.B.E., M.I.E. (Ind.), 21|1, Mandeville Gardens, Ballygungs, Calcutta

BHIDE, B. V., M.Sc., A.I.I.Sc., S. P. College, Poona 2.

BISWAS, Haragopal, Research Chemist, Bengal Chemical & Pharmaceutical Worws. Ltd., 164, Maniktolla Main Road, Calcutta.

BISWAS, K., M.A., D.Sc. (Edin.), F.R.S.E., Superintendent, Royal Botanic Garden, Calcutta and Honorary Lecturer in Botany, Calcutta University; P.O. Botanic Garden, Howarh.

BISWAS, Mohini Mohan, Research Chemist, Bengal Chemical & Pharmaceutical Works Ltd., 164, Maniktalla Main Road, Calcutta.

BISWAS, P. C., M.Sc., Ph.D. (Berlin), Reader in Anthropology, Delhi Universoty, Delhi.

BISWAS, S., M.Sc., 16D, Shamananda Road, Bhowanipore, Calcutta.

BOND, C. L., Standard Vacum Oil Co., Ltd., 6, Church Lane, Calcutta.

BOSE, Ajit Kumar, B.A., Prop. Calcutta Wood Distibution, 49, Shambazar Street, Cal.

BOSE, A. K., M.Sc., M.B., M.R.C.S., (Eng.), M.R.C.P. (Lond,), No, 3, Creek Row, Calcutta.

BOSE, A. N., Bararee Coke Co., Ltd. Kusunda P.O. (Manbhum).

BOSE, A. N., M.B., Pharmacologist, Bengal Immunity Research Institute, 39-B, Lower Circular Road, Calcutta 16.

BOSE, Arabinda Nath, Ph.D., Prof. of Food Technology, College of Engineering and Technology, Jadavpur, 24-Parganas.

BOSE, B. C., M.D., D.Sc., D.T.M., Pharmacologist Bio-chemical Standardization Laboratory, Central Research Institute P.O., Kasauli (Simla Hills). Punjab.

BOSE, Benoy Kumar, M.Sc., D.I.C., A.Inst.M.M., Chief Assayer, India Government Mint, Bombay 1.

BOSE, (Mrs.) Chameli, B.Sc. (Lond.), Statistician, Satistical Laboratory, Presidency College, Calcutta.

BOSE, D. M., D.Sc., F.N.I., Director, Bose Institute, 93, Upper Circular Road, Calcutta.

BOSE, G., D.Sc., M.B., F.N.I., Head of the Department of Experimental Psychology, University of Calcutta, Calcutta.

BOSE, I. B., D.Phil. (Berlin), Pharmaceutical Chemist, Central Drugs Laboratory, Govt. of India, 110, Chittaranjan Avenue, Calcutta.

BOSE, J. K., M.A., B.L., P.R.S., Ph.D., (Lond.), F.R.A.I., Labour Adviser, Indian Engineering Association, Bengal Chamber of Commerce, 46-7A, Ballygunge Place, Calcutta.

BOSE, Major Nikhiles, D.A.Q.M.G., H.Q., Nagpur Area, Kampetee, (C.P.).

BOSE, Nirmal Kumar, M.Sc., Lecturer in Anthropology, University College of Science, 35, Ballygunge Circular Road, Calcutta.

BOSE, P. C., B.Sc., (Glas.), M.I.E., Chief Engineer, Public Health, Govt. of West Bengal, Office of the Deputy Director of Health Services, Calcutta.

BOSE, P. C., Electrical Engineer, 35A, Lansdowne Road, Calcutta.

BOSE, P. K., D.Sc., Director, Indian Lac Research Institute, Namkum P.O. Ranchi.

BOSE, Phanindra Nath, M.B., D.T.M., D.P.H., Asst. Professor of Microbiology, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta 12.

BOSE, Purnendu Kumar, M.Sc., Lecturer, Department of Statistics, Calcutta University, Asutosh Building, Calcutta.

BOSE, Raj Chandra, M.A., F.N.I., Head of the Department of Statistics, Calcutta University, Asutosh Building, Calcutta.

BOSE, Satyendra Nath, M.Sc., F.N.I., Khaira, Professor of Physics, University College of Science, 92, Upper Circular Road, Calcutta.

BOSE, Saurindranarayan, Managing Director, Power and Machinery (India) Ltd., 3, Mangoe Lane Calcutta.

BOSE, S. K., B.Sc., P304, Jotindra Road, P.O. Rashbehari Avenue, Calcutta 29.

BOSE, S. K., M.Sc. (Cal.), Geological Survey of India, 27, Chowringhee, Calcutta.

BOSE, S. R., Ph.D., F.R.S.E., F.L.S., F.N.I., Professor of Botany, Carmichael Medical College, Calcutta.

BOSE, Subodh Chandra, M.A., Professor of Geography, Asutosh College, Calcutta.

BOSE, Sudhir Kumar, M.Sc., M.A., General Secretary, Indian Psychological Association, 92, Upper Circular Road, Calcutta.

BOSE, Susil Kumar, M.Sc., Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

BRAHMACHARI, Nirmal Kumar, M.Sc., 19, Loudon Street, Calcutta.

BRAHMACHARI, Phanindranath, M.Sc., M.B., M.D., 19, Loudon Street, Calcutta.

BURMAN, U. R., M.Sc., Lecturer in Applied Mathematics, University College of Science, 92, Upper Circular Road, Calcutta.

C

CALCUTTA Industrial Chemicals and Minerals Co., Ltd., 43, Dharamtola Street, Calcutta.

CAWNPORE Sugar Works Ltd., Marhawari Factory, P.O. Marhawrah (Saran).

CAWS, A., Begg, Sutherland & Co., Ltd., Marhowrah, Saran District, (Bihar).

CHACKO, P. I., B.A., B.Sc. (Hons.), F.Z.S., Asst. Director of Fisheries (Inland Development), 8, Ormes Road, Kil Pauk, Madras.

CHAKKO, K. C., B.A., D.Sc. (Lond.), M.I.E. (Ind.), Head of the Department of Engineering & Technology, Annamalai University, Annamalainagar.

CHAKRABARTI, Bijoy Kumar, M.Sc., M.B., Assistant Professor of Biochemistry, Assam Medical College, Dibrugarh, Assam.

CHAKRABARTI, Mukunda Chandra, Lecturer, Dacca University; 11, Northbrook Hall Road, Dacca.

CHAKRABARTY, Manindra Mohan, M.Sc., Lecturer in Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

CHAKRABORTY, C. H., M.Sc., Lecturer in Biochemistry, Department of Biochemistry, Nagpur University, Nagpur.

CHAKRABORTY, Saroj Kumar, M.Sc., Asst. Manager (Apparatus), Bengal Chemical and Pharmacheutical Works, Ltd., 164, Manicktollah Main Road, Calcutta.

CHAKRABORTY, Subodh Kumar, D.Sc., 2, Preonath Banerjee Street, Calcutta.

CHAKRAVARTI, Amulyaratan, B.Sc., M.B. (Cal.), F.R.C.P., F.R.S.E., Consulting Physician and Biochemist, 1, Furriapooker Street, Calcutta.

CHAKRAVARTI, B. C., M.Sc., M.M.G.I., F.G.M.S., Mining Geologist, Indian Aluminium Co-, Ltd., P.O. Lahardagee, Ranchi.

CHAKRAVARTI, D. K., B.E., A.M.I.E. (Ind.), Chartered Engineer, 10, Convent Road, Calcutta

CHAKRAVARTI, Dhirendra Kisore, M.Sc., F.G.M.S., Prof of Petrology Dept. of Geology, Beneras Hindu University Benares.

CHAKRAVARTI, Dukhaharan, D.Sc., Lecturer in Chemistry, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

CHAKRAVARTI, G. K, Zoological Laboratory, University College of Science, 35, Ballygunge Circular Road, Calcutta.

CHAKRAVARTI, Khagendra Nath, M.Sc, Professor of Mathematics, Presidency College, Calcutta.

CHAKRAVARTI, M. M., Zoological Laboratory, University College of Science, 35, Ballygunge Circular Road, Calcutta.

CHAKRAVARTI, Shri N., M.I.E.E., Principal, Thomson College of Engineering, Roorkee, U. P.

CHAKRAVARTI, N., B.Sc. (Cal.), M.A. (Cantab), A.M.I.E. (Ind.), Director, Provincial Statistical Bureau, West Bengal, Writers' Buildings, Calcutta.

CHAKRAVARTI, N. P., Ph.D., Joint Director-General of Archaeology in India, Curzon Road Barracks, New Delhi.

CHAKRAVARTI, Nani Gopal, Professor of Chemistry, Presidency College, Calcutta.

CHAKRAVARTI, S. C., Capt. M.B., 97, Keshab Chandra Sen Street, Calcutta.

CHAKRAVARTI, S. P., M.Sc., (Eng.), D.I.C., M.I.E.E., Principal, Govt. Engineering College, P.O. Gokulpore, Jubbulpore.

CHAKRAVARTY, Makhan Lal, M.Sc., M.B., Ph.D., Department of Biochemistry, Medical College, Calcutta.

CHAKRAVARTY, Surapati, B.Sc., M.A., Technical Expert, National Chemical & Salt Works (India) Ltd., 5, Commercial Buildings, Clive Street, Calcutta.

CHAKRAVORTI, S., L.R.C.P. (Lond.), M.R.C.P. (Eng.), Staff Medical Officer, Imperial Chemical Industries (India) Ltd., 18, Strand Road, Calcutta 1.

CHAKRAVORTY, S. C., M.Sc., Assistant Chemist, Geological Survey of India, 27, Chowringhee, Calcutta.

CHAKRAVORTY, Sailesh, M.Sc., Assistant Geologist, Geological Survey of India 27, Chowringhee, Calcutta.

CHANDRA, D. K., M.Sc., Assistant Geologist, Geological Survey of India, 27, Chowringhee Calcutta.

CHANMUGAN, W. R., F.R.I.C., D.I.C., Government Analyst, Government Analyst's Laboratory, Colombo 7, Ceylon.

CHANPATIA Sugar Factory, Chanpatia, P.O., Dist. Champaran.

CHARIAR, V. R., Asst. Professor of Mathematics, Science College, Patna.

CHATTERJEE, A., M.B.B.S., Hony. Secretary, Students Welfare Committee and Lecturer in Anthropology, University of Calcutta.

CHATTERJEE, B. K., D.Sc. (Paris), Anthropologist, Dept. of Anthropology, Indian Museum, Calcutta.

CHATTERJEE, Bimal Kumar, M.Sc., Lecturer in Zoology, Presidency College, Calcutta.

CHATTERJEE, C., Rai Sahib, Head of the Department of Engineering, Nagpur University, Nagpur.

CHATTERJEE, G. C., B.Sc., A.I.S.M., Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

CHATTERJEE, I., Indian Council of Agricultural Research, New Delhi.

CHATTERJEE, Jyotirmoy, B.A., M.B., Research Worker, 84, Russa Road South, Tollygunge P.O., Calcutta.

CHATTERJEE, K. C., C|o. Boots Pure Durg Co. (India) Ltd., Sion Works, Bombay 22.

CHATTERJEE, K. R., B.Sc., L.M.P., Asst. Medical Officer, Albert Victor Leprosy Hospital. 32, Gobra Road, Calcutta 14.

CHATTERJEE, Krishnadhan, M.D. (Cal.), 6, Amrita Banerjee Road, Kalighat, Calcutta.

*CHATTERJEE, M. L., M.B., Pharmacologist, Bengal Drug Control Unit, Department of Pharmacology, School of Tropical Medicine, Chittaranjan Avenue, Calcutta.

CHATTERJEE, Manomohan, B.Sc. (Cal.), Ph.D. (Lond.), A.R.C.S., D.I.C., Professor of Geology, Presidency College, Calcutta.

CHATTERJEE, N. C., Rao Bahadur, D.Sc., F.N.I., A.I.I.Sc., 18, Rajpur Road, Dehra Dun.

CHATTERJEE, Nirmal Nath, M.Sc., Lecturer in Geology, Calcutta University, Presidency College, Calcutta.

CHATTERJEE, Nripendra Nath, Examiner of Patents, 214, Lower Circular Road, Calcutta.

CHATTERJEE, P. K., M.Sc., P.R.S., Geologist, Geological Survey of India 27, Chowringhee, Calcutta.

CHATTERJEE, S. D., D.Sc., Research Fellow, Bose Research Institute, 93, Upper Circular Road, Calcutta.

CHATTERJEE, S. N., Secretary and Chief Executive Officer, Nagpur Municipality, Nagpur.

CHATTERJEE, S. P., M.Sc., Ph.D., (Lond.), D.Litt.(Paris), Head of the Department of Geography, Calcutta University, Senate House, Calcutta.

CHATTERJEE, Sajani Kumar, M.B., D.P.H. (Cal), D.T.M. (L'pool), Officer-in-Charge, Provincial Public Health Laboratory, Bankipore, P.O. Patna.

CHATTERJEE, Sri Sati Nath, 190, Lansdowne Road Calcutta.

CHATTERJEE, Satya Charan, D.Sc., F.R.G.S., F.G.M.S., Professor of Geography, Patna College Patna.

CHATTERJEE, T. D., Engineer-in-Charge, High Power Transmitters, All India Radio, Kingsway, Delhi.

CHATTERJI, A. C., D.Sc., Dr. Ing., Porf. and the Head of the Chemistry Dept., and Public Analyst to the U.P. Govt., Lucknow University, Lucknow.

CHATTERJI, Banbihari, M.Sc., M.B., Medical Practitioner and Lecturer in Physiology Calcutta University, 92, Upper Circular Road, Calcutta.

CHATTERJI, (Mrs.), Bani, D.Mus., Sangeeta-Varati, C|o. Dr. S. K. Chatterji, M.B., D.T.M., Ph.D., Chemical Department, Medical College, Calcutta.

CHATTERJI, N. G., D.Sc., D.I.C., A.M.I.Chem. E., Chemical Engineer, Tilak Road, Merut, (U. P.).

CHATTERJI, Pronay Kumar, Asst. Superintendent, Statistical Surveys, Indian Statistical Institute, Presidency College, Calcutta.

CHATTERJI, S. K., M.B., D.T.M. (Cal.), Ph.D. (Edin), Chemical Examiner to the Government of West Bengal, Medical College, Calcutta.

CHATTERJEE, S. N., Electrical Engineer, C|o. B. I. Callenders' Cables Ltd., 9, Hare Street, Calcutta.

CHATTOPADHYAY, K. P., M.Sc. (Cantab), Professor of Anthropology, University College of Science, 35, Ballygunge Circular Road, Calcutta.

CHAUDHURI, Anil, M.Sc., M.B., D.T.M., Medical Practitioner and attached to Carmichael Medical College, Calcutta.

CHAUDHURI, B. N., B.E., A.M.I.E., M.R.S.I. (Lond.), Civil Engineer Architects, 1-1B, Mission Row, Calcutta.

CHAUDHURI, Hiran C., M.A., Ph.D. (Lond.), Ph.D. (Edin.), Special Officer, Potatoes, Department of Agriculture, Government of West Bengal, Writers Building, Bloc No. 1 (Top flor), Calcutta.

CHAUDHURI, J. P., M.B. (Cal.), D.P.H. (Lond.), D.T.M. (L'pood), D.P.H. (Edin,), Health Officer, District 1, Calcutta Corporation, 102|2, Serpentine Lane, Calcutta.

CHAUDHURI, K. C., 56|2, Creek Row, Calcutta.

CHAUDHURI, (Mrs.) Mamata, 4, Beli Avenue, Allahabad.

CHAUDHURI, Muktipada, Ph.D., 21, Kailas Bose Street, Calcutta.

CHOUDHURI, S. S., Electrical Engineer, The General Electric Co. (India) Ltd., Magnet House, Central Avenue, Calcutta.

CHAUDHURI, (Miss) Sujata, M.R.C.P., (Lond.), M.R.C.P. (Edin.), D.C.H., (Lond.), The Countess of Dufferin's Fund Council, Viceregal Estate, Red Cross Building, 20, Talhatoria Road, Simla.

CHAUDHURY, Hari Shankar, M.Sc., D. Phil., Orissa Education Service Class 1., Professor of Zoology, Rameshaw Callege, Cuttack.

CHAUHAN, B. S., M.Sc., Ph.D., F.Z.S., Assistant Superintendent, Zoological Survey of India, Kaiser Castle, Benares Cannt.

CHAVAN, A. R., B.Sc., Ph.D., (Nebraska), Professor of Biology, Baroda College, Baroda.

CHHABRA, B., Ch., M.A., M.O.L., Ph.D., Govt. Epigraphist for India, Ootacamund.

CHHABRA, B. Ch., Offg. Government Epigraphist for India, Ootacamund.

CHHAPGAR, S. K., Shapur Baug, B-6, V. Patel Road, Bombay 4.

CHHIBER, H. L., M.Sc., Ph.D., D.I.C., D.Sc., (Lond.), Lead of the Department of Geography, Benares Hindu University, Benares.

CHINOY, J. J., Head of the Botany Dept. University of Delhi, Delhi.

CHIPLONKAR, G. W., D.Sc., Reader in Geology, Guints of Saugar, C.P.

CHIPLONKAR, M. W., D.Sc., 'Herakles Home,' Poona 4.

CHITRE, G. D., Rao Bahadur, L.M.S., Plot No. 73, Suparibag Road, Parel, Bombay.

CHONA, B. L., Ph.D. (Lond.), D.I.C., Indian Agricultural Research Institute, New Delhi.

CHOPRA, B. N., D.Sc., F.N.I., Superintendent, Zoological Survey of India, Kaiser Castle Benares Contonment.

CHOPRA, Sir R. N., Kt., C.I.E., M.A., M.D., F.R.A.S.B'., F.N.I., I.M.S. (Retd.). Director, Drug Research Labratory Jammu & Kashmir State, Jammu, Tawi.

CHOUDHURY, A. P., M.Sc., Asst. Tech. Officer, I.C.I., 18, Strand Road, Calcutta.

CHOWDHURY, Amal Chandra, M.Sc., Lecturer in Mathematics, Calcutta University, Calcutta.

CHOWDHURY, Dhinendra Kumar, M.Sc., C|o Mr. H. C. Ghosh, 4, Juslice Chandra Madhab Road, Calcutta 20.

CHOWDHURY, J. K., M.Sc., Ph.D. (Berlin), F.N.I., Head of the Dept. of Chemistry, Bose Institute, 93, Upper Circular Road, Calcutta.

CHOWDHURY, K. Ahmad, M.B.E., D.Sc. (Edin.), M.Sc., F.N.I., Wood Technologist, Forest Research Institute, New Forest, P.O. Dehra Dun, U.P.

CHOWDHURY, S. S., M.A., M.Sc., Professor, Science College, Mayapuri, Kodamkuan P.O., Patna (Bihar).

COATES, Joseph, A.R.S.M., F.G.S., A.M.Inst.Pet., Geologist, The Burmah Oil Co., Ltd., 11, Garasadoy Road, Ballygunje, Calcutta.

COCKRANE, R. G., M.D., Govt. Lady Wellingdon Leprosy Sanatorium, Chingleqet, Madras Presidency.

* CURSERJEE, (Miss) J. M., 'Behistan', 169, Colaba Road, Bombay 5.

D

DAKSHY, S. N., B.Sc., B.E. (Elec.) (Cal.), Office of the Asst. Engineer, Western Electrical Sub-Division, No. 1, W. & B. Dept., Govt. of West Bengal, Kidderpore Bridge Approach, P.O. Hastings, Calcutta 22.

*DALAL, Ardeshir, Kt., I.C.S. (retd), Director, Tata Sons Ltd., Bombay House, Bruce Street, Bombay.

DALAL, (Miss) L. H., Mukund Mansion, 2nd Floor, Vithalbhai Patil Road, Bombay 4.

DALAL, Phiroz Ardeshir, L.M. & S. (Bom.), D.T.M. & H. (Camb)., Professor of Bacteriology, Grant Medical College, Bombay.

DAMODARAN, M., M.A., D.Sc. (Lond.), F.R.I.C., Asst. Director, Biochemistry, Council of Scientific and Industrial Research, University Buildings, Delhi.

DAS, Atulananda, I.F.S. (retd.), F.L.S., F.R.S.E., Arunoday, Laban, Shillong.

DAS, B. K., D.Sc. (Lond.), Professor of Zoology, Osmania University College, Hyderabad Deccan.

DAS, Balai Chandra, M.Sc., Imperial Serology Dept,. School of Tropical Medicine, Calcutta.

DAS, Bhupendra Chandra, M.Sc., Professor of Mathematics, Presidency College, Calcutta.

DAS, Biraj Mohan, Rai Bahadur, M.A. (Cal.), M.Sc. (Leeds), Superintendent, Bengal Tanning Institute, P.O. Tangra, Calcutta.

DAS, Ganadeb, 15 Rama Prasad Roy Lane, Calcutta.,

DAS, K., Professor of Botany and Head of the Biology Dept., Assam Agricultural College, Jorhat, Assam.

DAS, M. S., B.Sc., M.R.C.V.S. (Lond.), Bengal Higher Veterinary Service, Bengal Veterinary College, Belgachia, Calcutta.

DAS, N. C., M.Sc. (Dacca), Assistant Chemist, Geological Survey of India, 27, Chowringhee, Calcutta.

DAS, N. N., M.Sc., M.B., Lecturer in Physiology, University College of Science, 92, Upper Circular Road, Calcutta.

DAS, S. C., M.B. (Cal.), Ph.D. (Edin.), F.R.S.E., Department of Pharmacology, Robertson Medical College, Nagpur, C. P.

DAS, Srimant Lal, B.Sc., Diploma in Education, Bakergunj Gloa, P.O. Bankipore, Patna.

DAS, Tarak Chandra, M.A., Lecturer in Anthropology, 93, Ballygunge Place, Calcutta.

DAS GUPTA, B. C., B.Sc., A.M.I.E.E., Engineering Dept., C|O. G.E.C. (India) Ltd., Magnet House, Central Avenue, Calcutta.

DAS, GUPTA, C. R., M.B., D.T.M., Officer-in-Charge, Haematology Department, School of Tropical Medicine, Calcutta.

DAS GUPTA, P. N., Professor of Mathematics, Science College, Patna.

DAS GUPTA, P. R., M.B., Senior Visiting Physician, Lake Medical College Hospital' Calcutta.

DAS *Gupta*, S. K., M.Sc., Geological Survey of India, 27, Chowringhee, Calcutta.

DAS GUPTA, Satindra, M.Sc., Research Chemist, B.C.P.W., 104, Maniktolla Main Road, Calcutta.

DAS-GUPTA, S. N., Ph.D. (Lond.), D.I.C., Reader in Botany, Luknow University, Lucknow.

DAS-GUPTA, S. S., M.Sc., Burmah-Shell Inspector, P.O. Kadamkuan, Patna,

DASTUR, Noshir N., Dairy Chemist, Imperial Dairy Research Institute, Hosur Road, Bangalore.

DASTUR, R. H., M.Sc., F.N.I., Plant Physiologist, Institute of Plant Industry, Indore, (C. I.).

DATT, J., B.A. (Hons.), C.E., A.M.I.E., Dt. Engineer, The Concrete Association of India, Mithapur, Patna Junction.

DATTA, Manoranjan, M.Sc., (Cal.), M.Sc., Tech. (Manchester), A.M.I.E.E. (Lond.), Office of the Chief Electrical Engineer, Govt. of Bengal. 4, Hastings Street, Calcutta.

DATTA, S., D.Sc. (Lond.), M.R.C.V.S., F.R.S.E., D.T.V.M., F.N.I., Director, Indian Veterinary Research Institute, Izatnagar.

DATTA, Santosh Chandra, Chemical Laboratory, University of Dacca, Ramna, Dacca.

DATTA, S. K., M.Sc., A.Inst.P. (Lond.), Manager, The Scientific Industrial Co., Ltd., 30, Mount Road, Madras.

DATTA-MAJUMDER, N., B.L., M.A. (Econ.), M.A. (Anthrop), Ph.D. (Anthrop.), F.R.A.I., 101A, Ballygunge Place, Calcutta.

DEVENDRA, D. T., Sivali Vidyalaya, Ratnapura.

DAVER, M. B., M.B., B.S. (Bom.), F.R.F.P.S. (Glass.), D.P.H. (Eng.),F.R.I.P.H. (Eng,), Asst. Director, Bureau of Nutrition, H.E.H. The Nizam's Dominion, 231-A, Maradpalli, Secunderabad-Deccan.

DAYAL, B., D.Sc., A.I.I.Sc., Asst Professor of Physics, Benares Hindu University, Benares.

DAYAL, Jagadeshwari, D.Sc., Lecturer in Zoology, Lucknow University, Lucknown.

DAYAL, P., M.A., Ph.D. (Lond.), Head of the University of Ceylon, Colombo 3.

DE, A. K., Ph.D., D.I.C. (Lond.), Superintending Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

DE, K. L., District Engineer, District No. 1, Calcutta Corporation, 79, Cornowallish Street Calcutta.

DE, M. K., M.Sc. (Dac.), Assistant Chemist, Geological Survey of India, 27, Chowringhee, Calcutta.

DE, Nagendranath, M.B., D.T.M. (Cal.), M.R.C.P. (Edin.), D.P.M. (Lond.), Visiting Physician, Lumbini Park Mental Hospital, Psychological Clinic at Carmichael Medical College and Psychological O.P.D., 44, Badur Bagan Street, Calcutta.

DE, Premankur, B.Sc. M.B. (Cal.), F.R.C.P. (Edin.), F.N.I., Professor of Physiology, Medical College Calcutta.

DE, S. S., D.Sc., Lecturer in Food Technology, Deparment of Biochemistry, Indian Institute of Science, Bangalore .

DE, U. N., M.Sc., Biochemist, Dept., of Biochemistry & Diabetes, School of Tropital Medicine, Calcutta.

DEB, S., Docteur-es-Sciences (Paris), Professor of Geology, College of Engineering and Technology, Bengal, Jadavpur, College P.O., 24-Parganas.

DEB, S. (Jr.), Ceramic Engineer, Bengal Porcelain Co., Ltd., 3, Moti Sil Street, Calcutta.

DEB, (Mrs.) Santa, M.A., B.T., T.D. (Lond.), Department of Psychology, University College of Science, Calcutta.

DEHADAI, P. V., Lecturer, Dept. of Geology, University of Saugar, Sugar, C. P.

Deputy Director General of observation, climatology & Geophysico, Poona 5.

DEOLALKAR, T. K., M.A., Retired Professor of Physics, Chandrasadan, Dharwar.

DEORAS, P. J., Ph.D. (Dunelm) 9 Empire Hindu Hotel, Hornby Road, Bombay.

Deputy Director General of ovservatories, Climatolagy & Geophysics, Poona 5.

DERANIYAGALA, P. E. P., Director, National Museum, Colombo Museum, Colombo.

DESAI, R. D., M.Sc. (Bom.), D.Sc., (Lond.), F.N.I., F.I.I.Sc., F,A,Sc,, D,I,C,, Dept, of Chemical Technology, Matunga, Bombay.

*DESAI, Shrishkhant Varajray, D.Sc. (Lond.) Ph.D. (Lond.) D.I.C., 2nd Agricultural Chemist, Indian Agricultural Research Institute, New Delhi.

DESHMUKHA, G. S., Dept. of Chemistry, College of Science, Beneres Hindu University, Beneres.

DESHPANDE, Major H. B., M.Sc., F.I.M., M.I.S.I., M.B.E., M.Inst. Met. (Lond.), Chief Chemist & Metallurgist, Kharagpur, B. N. Rly.

DEWAN, R. N., M.Sc., 5, Doctor's Lane, New Delhi.

DEY, A. K., M.Sc., D.Phill., Lecturer in Chemistry, University of Saugar, Saugar, C.P.

DEY, B. B., M.Sc., (Cal.), D.Sc. (Lond.), F.I.C., F.N.I., I,E,S,, Director of Public Instruction, Cathedral P.O., Madras.

DHAR, A. N. Dr. Ing. (Dresden.), B.Sc., M.I.S.E. (Cal.), Provincial Industrial Research Laboratory, Science College, Patna.

DHAR, Jagattaran, M.Sc., A.Inst.P., Head of Department of Physics and Mathematics, Indian School of Mines, Dhanbad.

DHARMATTI, S. S., Royal Institute, of Science, Fort, Bombay.

DHINGRA, D. R., M.Sc., Ph.D., Industrial Chemist to Govt. of U.P. Harcourt Butler Technological Institute, Cawnpore.

DHOLAKIA, J. K., M.I.M.E., Agent, Balihari Colliery Co., Ltd., P.O. Kusunda, Manbhum.

DIKSHIT, B. B., Ph.D., M.B., M.R.C.P., D.P.H., Officer-in-Charge, Department of Pharmacology, Haffkine Institute, Parel, Bombay.

DINAMANI, P., B.Sc., (Hons.), Research Assistant, Office of the Asst. Director of Fisheries, Inland Development, 8, Ormes Road, Kilpauk, Madras 10.

Director of Agriculture, Assam, Shillong.

Director, Regional Meteorological Centre, Calcutta.

DIXIT, K. R., Professor of Physics, Royal Institute of Science, Bombay.

DOJA, M. Q., B.Sc. (Pat.), B.A. (Cantab), A.R.P.S., Professor of Organic Chemistry and Head of the Department of Chemistry, Science College, Patna.

DOLE, Krishnaji Khando, M.Sc., Ph.D., Professor of Chemistry, Fergusson College, Poona, 4.

DOSS, K. S., Gururaja, D.Sc., F.I.C., A.Inst.P., F.A.Sc., Physical Chemist, Imperial Institute of Sugar Technology, Cawnpore.

DUBEY, R., Head of the Department of Geography, Allahabad University, Allahabad.

DUTT, G. N., M.Sc., Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

DUTT, K. K., B.Sc., A.I.S.M., Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

DUTT, Kaviraj Atul Behari, B.Sc., Kaviratna, Superintendent, Bangiya Unmad Asram, 29A, Vivekananda Road, Calcutta 7.

†DUTT, N. L., M.Sc., Assoc.I.A.R.I., Sugarcane Expert, Government of India, Imperial Sugarcane Station, Lawley Road, Coimbatore, S. India.

DUTT, R., Inspecting Officer, Department of Industries and Supplies, P-18, Mission Row, Extension, Calcutta.

DUTTA, Ajit Kumar, M.Sc., Research Assistant, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.

DUTTA, Arun Kumar, D.Sc., Lecturer in Physics, University College of Science, 92, Upper Circular Road, Calcutta.

DUTTA, Bijon, 15-1-2, Rani Sankari Lane, P.O. Kalighat, Calcutta.

DUTTA, Narendra Lall, Junior Research Officer, Council of Scientific & Industrial Research University Buildings, Delhi.

DUTTA, P. K., Colliery Manager, Karmatand Colliery, P.O. Karmatand, Manbhum.

DUTTA, S. K., M.Sc., Metallurgical Laboratory, Inspectorate of Metal & Steel, Ishapore (West Bengal).

DUTTA, ROY, R. K., M.Sc., Dr. Ing., F.N.I., Chemist, Geological Survey of India, 27, Chowringhee, Calcutta.

E

EAST India Distilleies & Sugar Factories Ltd., Nellikuppam, South Arcot District.

*EVANS, Percy, B.A., F.G.S., F.N.I., Chief Geologist, The Burmah Oil Co., Ltd., Britannic House, Finsbury Circus, London, E. C. 2, England.

EZEKIEL, Moses, Professor of Botany, Wilson College, Bombay 7.

F

FAROOQ, M. Omar, Dept., of Chemistry, Muslim University, Aligarh.

FASEEH, S. A., M.A , M.Sc., Lecturer in Chemistry, Lucknow University, Lucknow.

FERMOR, Sir Lewis Leigh, Kt., O.B.E., DSc. (Lond.), F.R.S., A.R.S.M., M.Inst.M,M, F.G.S., F.N.I., F.R.A.S.B., Late Director, Geilogical Survey of India; 24, Durd, ham Park, Bristol, 6, England.

FOWLER, Gilbert J., D.Sc., F.I.C., F.R.San.I., F.N.I., Central Hotel, Bangalore.

G

GAN, G. K., Park Avenue, Dhantoli, Nagpur.

GANPATI, S. V., M.Sc., A.R.I.C., Hydrologist, Fisheries, Freshwater Biological Research Station, Kilpauk, Madras.

GANGULI, A. K., General Manager, The Scientific Instrument Co., Ltd., 11, Esplanade East, Calcutta.

GANGULI. Arun, Z.D.S. (Vienna), 26, Chowringhee, Road Calcutta.

GANGULI, Dhirendra Mohan, Dy. Superintendent, Statistical Surveys, Indian Statistical Institute, Presidency College, Calcutta.

GANGULY, Dhirendra Nath, M.Sc., Licturer in Zoology University College of Science, 35, Ballygunge Circular Road, Calcutta.

GANGULY, Dwijendralal, M.Sc., Psychology Department, Calcutta University, Calcutta.

GANGULY, J., B.E., M.I.E., (Ind.), 7|1|A, Mohan Lall Street, Calcutta.

GANGULY, P. B., D.Sc., F.N.I., Principal Science College, Bankipore, Patna.

GARDE, G. M., Technical Chemist, Jeewajiganj, Lasakar, Gwaliar.

GARG, Shivchandra, B.Sc., Behari Bhavan Kaisarganj, Ajmer.

GENERAL Manufacturing Company, (Manufacturers of Balances and Scientific Instruments), Sonarpura, Benares.

GEOLOGICAL Survey of India, The Director, 27, Chowringhee, Calcutta.

*GHADIALY, Pestonji F., F.R.G.S., F.R.S.A., F.B.H.I. (Lon.), M.M.E.A., A.M.A.E., M.I'S.E., Senior Scientific officer, Engineesing Inteligence Service, Delhi.

GHAFFAR, A., M.B., D.T.M. (Cal.), Ph.D. (Edin.), Lecturer in Physiology, Robertson Medical School, Nagpur.

GHANDY, Sir Jehangir J., Kt., C.I.E., B.A., B.Sc., M I.E., F.Inst.F., M,I,S,I,, Agent, Tata Iron & Steel Co., ltd., 102A, Clive Street, Calcutta.

GHARPURE, P. V., M.D., D.T.M.&H., Major, I.M.S., Professor of Pathology, Gorant Medical College, Bombay 8.

GHATAK, *Narendranath*, D.Sc., Chemical Examiner to Govt. of U. P. & C.P., Agra.

GHOSE, S. K., M.Sc., Geologist, Hindusthan Minerals and Natural History Specimens Supply Co., 39, Russa Road, Tollygunj, Calcutta.

GHOSE, Sudhir Kumar, M.B. (Cal.), D.T.M. (L'pool), Chief Analyst, Calcutta Corporation, Calcutta.

GHOSH, A. K., Registrar, Bose Institute, 92, Upper Circular Road, Calcutta.

GHOSH, A. K., B.Sc., B.Sc., Eng (Lond.), Inspecting Officer, Indian Stores Dept., Controller of Inspect., P-18, Mission Row Extension, Calcutta.

GHOSH, A.M.N., B.Sc. (Cal.), B.Sc. (Hons.) (Lond), A.R.C.S. (Lond.), Superintending Geologist, Geological Survey of India, 27, Chowringhee, Calcutta

GHOSH, Aghore Nath, M.B., Publicity Officer, Bengal Chemical and Pharmaceutical Works Ltd., 164, Manicktola Main Road, Calcutta.

GHOSH, B. K., M. Sc., Chemist, Drug Control Laboratory, School of Tropical Medicine,

GHOSH, B. N., D.Sc., Reader in Chemistry, University College of Science & Technology, 92, Upper Circular Road. Calcutta.

GHOSH, B. N., M.B.E., F.R.F.P.&S. (Glas.), L.M. (Dublin), F.R.S, (Edin.), F,S,M,F, (Bengal), Professor of Pharmacology, Carmichael Medical College, Calcutta.

GHOSH, B. N., M.Sc., Central Drugs Laboratory, 110, Chittaranjan Avenue, Calcutta.

GHOSH, Bidhu Bhusan, B.E., C.E., A.M.I.E., M. Amer. Soc., R.E., A.M. Amer, Soc,, H.V.E., Deputy Director (Civil Engineering), Department of Supply, Government of India; 165, Janak Road, Calcutta.

GHOSH, Chandra Sekhar, M.Sc., S.M. (M.I.T.), A.M.A.I.E.E., M.I.E.S,A,, Lecturer, Deparement of Applied Physics, University College of Science and Technology, 92, Upper Circular Road, Calcutta 9.

GHOSH, Gopal Krishna, B.Sc., M.B. (Cal.), M.Sc. (Lond.), Head of the Department of Anatomy, P. W. Medical College, Bankipore P.O., Patna.

GHOSH, H., M.B. (Cal.), M.S.P.E., (Paris), Bacteriologist, 67, South Road, Entally, Calcutta.

GHOSH, J., M.A. (Cal.), Ph.D. (Edin.), F.N.I., Principal, Presidency College, Calcutta.

GHOSH, Jnan Chandra, Kt., D.Sc., F.N.I., Director-General of Industries & Supply, Government of India, New Delhi.

GHOSH, K. D., M.A. (Oxon.), Dip-in-Ed., Barrister-at-Law, Principal, David Hare Training College, Calcutta.

GHOSH, K. M., B.Sc., Assistant Chemist, Geological Survey of India 27, Chowringhee, Calcutta.

GHOSH, L. M., M.B., (Cal.), D.T.M. (L'Pool.), Dept., of Dermatology, School of Tropical Medicine, 74|4, Baghbazar Street, Calcutta 3.

GHOSH, Manindra Kumar, Tata Research Laboratory, P.O. Tatanagar, Jamshedpur.

GHOSH, Nares Chandra, M.Sc., Research Worker, I.R.F.A., School of Tropical Medicine, Calcutta.

GHOSH, N. L., M.Sc., Ripon College, Calcutta.

GHOSH, P. K., D.Sc., Deputy Director, Geological Survey of India, 27, Chowringhee, Calcutta.

GHOSH, P. K., B.Sc., Min. (Banaras), Geological Survey of India, 27 Chowringhee, Calcutta.

GHOSH, Prashanta Kumar, M.B., D.T.M. (Cal.), T.D.D. (Wales), M.R.C.P. (Lond.), M.R.C.P. (Edin.), Senior Physician, Mayo Hospital, Calcutta; P7/1, Chittaranjan Avenue Extension, Beadon Street, P.O., Calcutta.

GHOSH, Pulin Behari Prof. of Civil Engineering, Bengal Engineering College, P.O. Botanic Garden, Howrah.

GHOSH, R. N., D.Sc., F.N.I., Physics Dept., Allahabad University, Allahabad.

GHOSH, Rash Behary, Assistant Chemist, Geological Survey of India, 27, Chowringhee, Calcutta.

GHOSH, S., D.Sc., Department of Applied Mathematics, University College of Science, 92, Upper Circular Road, Calcutta.

GHOSH, S. M., M.B., Asst. Professor of Medical Entomology, School of Tropical Medicine, Chittaranjan Avenue, Calcutta.

GHOSH, S. N., B.C.P.W., 164, Manicktolla Main Road, Calcutta.

GHOSH, S. S., Asst. Wood Technologist, Forest Research Institute, New Forest P.O. Dehra Dun.

GHOSH, T., M.A., Statistician, United Commercial Bank Ltd., 2 Royal Exchange, Calcutta.

GHOSH, T. K., Manager, Messrs. B. K. Paul & Co., Ltd, 1, Bonfield Lane, Calcutta.

GHOSH, T. N., D Sc., Bengal Immunity Research Laboratory, 39-B, Lower Circular Road, Calcutta 16.

GHOSHAL, Amiya Kumar, M.Sc., Demonstrator in Chemistry, Medical College, Calcutta.

GHURYE, Govind Sadashiv, M.A. (Bom.), Ph.D. (Cantab), Head of the Department of Sociology, University of Bombay, Khar, Bombay.

GIDEON, P. W., M.A., Professor of Biology, Karnatak College, Dharwar (Bombay).

GILL, P. S., M.Sc., Ph.D., Prof. of Experimental Physics Tata Institute of Fundamental 53, Pedder Road, Bombay, 26.

GODBOLE, S. N., Rao Saheb, M.Sc., Dhantoli, Nagpur.

GOGATE, D. V., M.Sc., Ph.D., Professor of Physics, Baroda College, Baroda.

GOKHALE, Anant Gundo, Rao Bahadur, M.A., B.Sc., F.R.I.C., A.I.I.Sc., Superintendent, Government Central Distillery, Nasik Road, Bombay Presidency.

GOKHALE, Shanker Kashinath, B.A. (Hons.), M.Sc., A.I.I.Sc., Assistant Biochemist, Haffkine Institute, Parel, Bombay.

GONZALVES, (Mrs.) E., B.A., M.Sc., Lecturer in Biology, Karnatak College, Dharwar.

GOPAL, Ram, M.Sc., Ph.D., Lecturer in Chemistry, Lucknow University, Lucknow.

GOPALAKRISHNA, A., Lecturer in Zoology, College of Science, Nagpur.

GOPALAKRISHNAN, V. R., Rao Saheb, G.M.V.C., P.G., Veterinary Investigation Officer, Assam, Danish Road, Panbazar, P.O. Gauhati, Assam.

GOSLING, George W., F.R.M.S., Director, Messrs Martin & Harris, Ltd., 'Sudama House' Ballard Estate, Bombay.

GOSWAMI, M. N., D.Sc., Department of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

*GOSWAMI, S. K., B.E., Assistant Engineer-in-charge, C. E's Drawing Office, I & W. Directorate, Wreters' Building, Calcutta.

GREVAL, S. D. S., B.Sc., M.D., Ch.B., D.P.H., I.M.S., Imperial Serologist and Chemical Examiner to Government of India, School of Tropical Medicine, Calcutta

GUHA, A. C., M.B.B.S., D. Bact., 47A, Lake Avenue, Calcutta.

GUHA, B. C., Ph.D., D.Sc., (Lond.), F.N.I., Member, Damoder Valley Corporation, Anderson House, Alipur, Calcutta.

GUHA, Bhagawati Charan, D.Sc., Department of Physics, Presidency College, Calcutta.

GUHA, P. C., D.Sc., F.N.I, Professor of Organic Chemistry, Indian Institute of Science, Malleswaram, Bangalore.

GUHA, P. C., B.Sc., (Cal.), B.Sc. (M|c), 17-A, Lake Avenue, Calcutta.

GUHA, S. C., M.B., F.R.F.P.&S., Professor of Anatomy, Garjaraja Medical College, Gwalior.

GUHA-SARKAR, Sarbbani Sahay, D.Sc, D.I.C., Prof. of Chemistry, Chemical Labrotary, Ravenshaw College, Cuttack, Orissa.

GUPTA, A. K., B.A., (Cantab.), Imperial Chemical Industries (India) Ltd., 18, Stand Road, Calcutta.

GUPTA, J. C., M.B., Professor of Pharmacology, Calcutta School of Tropical Medicine, Calcutta.

GUPTA, P. D., Lecturer in Zoology, Lucknow University, Lucknow.

GUPTA, S., M.Sc., Reader in Theoretical Physics, Tata Institute of Fundamental Rech., 53, Pedder Road, Bombay 26.

GUPTA, (Miss) S B., B.A., B.T. (Cal.), Dip.-in-Edn. (Leeds), M. Ed. (Leeds), Fellow of Calcutta University, Inspectress of Schools, Presidency and Burdwan Divisions, Anderson House, Alipore, Calcutta.

GUPTA, Subodh Chandra, M.B., (Cal.), Asst. Surgeon Superintendent, B. I. S. N. Co., Ltd., 16, Strand Road, Calcutta.

H

H. R. H., The Prince of Wales Technical School, Principal, Nowgong, Assam.

HAI, M. A., Khan Sahib, M.D., M.R C.P. (Edin.), T.D.D. (Wales), Lecturer in Medicine, P. W. Medical College, Patna.

HALEY, Niel James, Assistant General Superintendent (General), The Tata Iron & Steel Co., Ltd., Jamshedpur.

HALL, Kenneth, C/o. Indian Aluminium Company Limited, 5, Council House Street, Calcutta.

HAMID, K. A., M.Sc., D.Phil, Managing Director, Cipla Laboratories, Bombay.

HARDIKAR, S. W., M.D., M.R.C.P. (Edin.), Professor of Pharmacology, Osmania Medical College, Hyderabad-Deccan.

HARRISON, C. J., B.Sc., O.B.E., Chief Scientific Officer, Indian Tea Association, Tocklai Experimental Station, Cinnamara P.O., Assam.

HATTIANGADI, R. R., B.A., M.Sc., Ph.D., D.I.C., The Associated Cement Co., Ltd., Esplanade House, Waudby Road, Fort, Bombay.

HATWALNE, Shri V. G., M.Sc., Lakshminarayan Fellow, Department of Biochemistry, Nagpur University, Nagpur.

HAZRA, A. K., M.B.B.S., D.T.M., Senior Bacteriologist, Haffkine Institute, Parel, Bombay 12.

HAZRA, P. C., B.Sc. (Cal.), B.Sc. (Lond.), A.R.I.C.S., Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

HEILIG, R. E., M.D. (Vienna), M.C.P. (Austria), F.N.I., Chief Physician, Lady Willingdon Hospital, Jaipur, Rajputana.

HIND Chemical Ltd., Manufacturing Chemist & Pharmacists, Cawnpore.

HIRACHAND, Lalchand, M.L.A., 'Construction House,' Wittet Road, Ballard Estate, Bombay.

HORA, Sunder Lal, Rai Bahadur, D.Sc. (Panjab et Edin.), F.L.S., F.Z.S., F.R.S.E., F.N.I., F.R.A.S.B., Director, Zoological Survey of India, Kaiser Castli, Benares Cantonment, U.P.

HUSAIN, M. Afzal, M.A. (Cantab), M.Sc. (Panj.), F.N.I., 56, Jail Road, Forman College, P.O., Lahore.

HUSAIN, Zakir, M.A., Ph.D., Principal, Jamia Milla Islamia, Jamianagar, Delhi.

HUSSAIN, Syed., M.Sc., Ph.D., (Lond.), Head of the Department of Chemistry, Osmania University, Hyderabad, Deccan.

*HUTTON, J. H., C.I.E., M.A., D.Sc., I.C.S., F.N.I., F,R,A,S,B,, University Museum of Archaeology and of Ethnology, Downing Street, Cambridge, England.

I

INDIAN Association for the Cultivation of Science, 210 Bowbazar Street, Calcutta.

INDIAN Decimal Society, 29/1A, Baldeopara Road, Beadon Street, P.O., Calcutta.

INDIAN Science News Association, 92, Upper Circular Road, Calcutta 7.

INDIAN Sugar Mills Association, The Secretary, Security House, 102-A, Clive Street, Calcutta.

INDIAN Veterinary Research Institute, The Director, Muktesar-Kumaun, U.P.

INDRA, M. K., M.Sc., Development Research Laboratory, B. O. C. Ltd., 11, Gurusaday Road, Calcutta.

INSPECTORATE of Military Explosives, Kirkee, Bombay.

IRAWATHY (Miss) A.R., Lecturer, Queen Mary's College, Madras.

IYENGAR, M. O. P., M.A., Ph.D., F.L.S., F.N.I., Director, University Botany Laboratory, Triplicate, Madras.

IYER, K. Sitarama, M.A., Chalai St., Tirvandrum, Travancore.

IYER, L. A. N., Rao Bahadur, Tata Professor of Geology, Patna University Patna.

IYER, S. Rama, K.I.H., L.M. & S., Retired Civil Surgeon (Burma Service), Devarayasamudram Post, Kolar District, Mysore.

J

JACOB, P. K., B.A., M.Sc., Asst. Director of Fisheries Marine Biology, West Hill, Malabar.

JADHAB, Ganpatrao Vishramrao, B.A., (Hons.), M.Sc., Ph.D., A.I.C., Department of Chemistry, Ismail Yusuf College, P.O. Jageswari, Bombay.

JALOTA, S., 6, Kosi Road, Jamshedpur. *R*

JATKAR, S. K. K., D.Sc., F.I.I.Sc., F.I.C., F.Inst.P., Department of Applied Chemistry, Indian Institute of Science, Malleswaram, P.O. Bangalore.

JENNINGS, B. R., 35, Chowringhee, Calcutta.

JHINGRAN, Anant Gopal, M.Sc. (Benares), Ph.D. (Durham), Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

JINARAJADASA, C., The Theosophical Society, Adyar, Madras.

JOB, T. J., D.Sc., Chief Research officer Central Fisheries (India), 2B, Outram Street, Calcutta 16.

JOIS, H. Subba, M.Sc., Professor of Organic Chemistry, Central College, Bangalore.

JONES, S., M.Sc., Research Officer, (Estuarine of General), Central Inland Fisheries Research Station, 2B, Outram Street, Calcutta.

JOSHI, A. C., D.Sc., F.N.I., Professor of Botany, Government College, Hoshiarpur.

JOSHI, Krishna Chandra, M.Sc., Research Scholar, Chemistry Dept., Lucknow University, Lucknow.

JOSHI, N. S., Rao Bahadur, B.E., (Civil), M.I.S., M.R.Sanl., (Lond.), Superintending Engineer, (Bombay P. W. D.), Dharwar.

JOSHI, N. V., M.Sc., L.Ag., Professor of Microbiology and Biochemistry, Fergusson College, Poona 4.

JOSHI, P. N., M.Sc. (Tech.), Principal and Secretary, Victoria Jubilee Technical Institute, Matunga, Bombay.

JOSHI, S. S., D.Sc. (Lond.), University Professor and Head of the Department of Chemistry and Principal, College of Science, Benares Hindu University, Benares.

JOURNOT, Claude, Joint Cultural Adviser to the French Embassy, Central Cultural De Calcutta, S|C Consulat General De France, 24, Park Mansions, Calcutta.

*KALAPESI, A. S., B.Sc., D.I.C., Ph.D. (Lond.) F.G.S., F.R.G.S., Professor and Head of the Department of Geology and Geography, St. Xavier's College, Cruickshank Road, Bombay, 1.

KALYANSUNDARAM, V., M.A., L.T., Junior Lecture in Geography, University of Madras, Triplicane P.O., Madras.

KANE, Covind Pandurang, M.Sc., Ph.D., (London), D.I.C., Department of Chemical Technology, Bombay University, Matunga Road Bombay 19.

KANGA, D. D., I.E.S., (Retd.), The Theosophical Society, Adyar, Madras.

KANTEBET, S. R., M.I.R.E., A.M.I.E.E., Engineer-in-Chief, Installation and Projects, Indian Radio and Cable Communications Co., Ltd., Radio House, Bombay 1.

KAPPANA, A. N., D.Sc., College of Science, Nagpur (C.P.).

KAR, A. B., M.Sc., Ph.D. (Edin.), F.P.Sc. (U.S.A.), Dept., of Zoology, University College of Science, 35, Ballugunge Circular Road, Calcutta

KAR, B. K., M.Sc., Ph.D., Prof. of Botany, Faculty of Science, Kabul University, Kabul, Afghanistan.

KAR, K. C., D.Sc., Physical Research Laboratory, Presidency College Calcutta.

KAR, Nisith Ranjan, M.Sc., Lecturer in Geography, Presidency College Calcutta.

KARKUN, J. N., M.Sc., Central Drugs Laboratory, 110, Chittaranjan Avenue, Calcutta.

KARUNAKARA, C. O., Public Health Laboratory, Trivandrum.

KARVE, D. D., M.Sc., Ph.D., A.I.I.Sc., Principal and Professor of Chemistry, Fergusson College, Poona 4.

KARVE, (Mrs.) Irawati, M.A., Ph.D., Reader in Sociology, Deccan College, Poona 1.

KASTHURI, Sri A. K., B.Sc. (Hon.), Asst., Professor of Geology, Presidency College, Trijlicane, Madras 5.

KATTI, M. C., Tumnin, M.Sc., Ph.D., Chief Chemist & Works Manager, Karnatak Chemical Works Gadag, M. & S. M. Ry.

KAUSALYA, (Miss) C.K., Lecturer in Natural Science, Queen Mary's College, Madras.

KEHAR, N. D., M.Sc., Sc.D., Officer-in-Charge, Animal Nutrition Section, Imperial Veterinary Research Institute, Izatnagar, (U.P.).

KERAWALA, S. M., M.A., (Cantab), Senior Professor of Mathematics, Presidency College, Calcutta.

KHAN, *Najib*, Lt., Col., Physician in-charge and Dy. Chief Medical Officer, Tata Main Hospital, 6, Lake Road, Jamshedpur.

KHANNA, K. L., B.Sc., (Agri.), Assoc.I.A.R.I., F.A.Sc., Sugarcane Specialist, Bihar Government, Pusa (B.N.W.Ry.).

KHASTGIR, S. R., D.Sc., F.N.I., M.I.R.E., Head of the Department of Physics, Dacca University, Ramna P.O., Dacca.

KHORANA, M. L., Dept. of Chemical Technology, Matunga, Bombay, 19.

KHOSLA, Ajudhia Nath, Rai Bahadur, I.S.E., Consulting Engineer for Waterways, Irrigation & Navigation, and Chairman Central Waterways, Irrigation and Navigation Commission, L Block, Imperial Secretariat, New Delhi.

KILPADY, Sripada, M.Sc., F.G.S., Head of the Department of Geology, Nagpur University, Nagpur.

KINI, M. G., M.C., M.B., M.Ch. (Orth.), F.R.C.S. (Edin.), F.R,S,E,, Superintendent, Stanley Hospital, Madras.

KISHIN, K., Statistician, Department of Agriculture, United Provinces, Lucknow.

KISHORE, Ram, B.A., A.M.I.E. (Ind.), Asst. Engineer, Irrigation Office, Cantonment Road, Lucknow.

KISHORE, Roop, M.Sc., Professor of Physics, Meerut College, Meerut.

KOCHAR, B. D., D.Sc., Glancy Medical College, Amritsar.

KOLHATKAR, G. B., M.A., A.I.I.Sc., Professor of Chemistry, Fergusson College, Poona 4.

*KONORIA, Gopi Krishna, Merchant and Banker, Post Box No. 7, Chowk, Patna City.

KORGAOKAR, M. N., Prof. and Head of the Department of Mathematics, M. N. College, Visnagar, Baroda State.

KOSAMBI, D. D., D.Sc., Tata Institute of Fundamental Research, 53, Peddar Road, Bombay 26.

KOTHARI, D. S., Ph.D., F.N.I., Head of the Department of Physics, University of Delhi, Delhi.

KOTHARI, H. C., Statistical Officer, Jaipur State, Jaipur.

KOTWAL, Y. N., B.A., B.Sc., A.I.I.Sc., Chemist-in-Charge, Dadar Purification Works, Dadar, Bombay.

KRISHNAN, B. T., Rao Bahadur, M.B.B.S., M.Sc., Principal and Professor of Physiology, Medical College, Mysore.

KRISHNAN, Sir K.S., F.R.S., Director, National Physical Laboratory, University Building, Delhi.

KRISHNAN, K. V., M.B.B.S., M.R.C.P., D.B., D.Sc., F.N,I,, Professor of Microbiology, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

KRISHNAN, M. S., M.A., Ph.D., A.R.C.S., D.I.C., F.N.I,, Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

KRISHNAN, R. S., D.Sc., Ph.D., Dept., of Physics, Indian Institute of Science, Malleswaram P. O., Bangalore.

KRISHNAMURTI, B., M.A., Fishery Research Officer, 8, Ormes Road, Kilpauk, Madras 10.

KRISHNANDAM, J., M.Sc., Chemical Engineer, Arumtelpeta, Bezawada.

KRISHNASWAMI, K. R., D.Sc. (Lond.), Industrial Chemist to Government of Bihar, Secretariat, Patna.

KRISHNASWAMY, V. D., M.A., Dip. Arch. (Cantab), Asst. Superintendent (Pre-history), Archaeological Survey of India, Southern Circle, Fort Street, Madras.

KULKARNI, G. S., M.Ag., Mycologist, Central Farm, Gwalior.

*KUMAR, Diwan Anand, M.A., M.Sc., Reader in Zoology, Government College, Lahore.

KUMAR, L. S. S., Rao Bahadur, Economic Botanist to Government, B. P., Poona 5.

KUNDU, B. C., M.A., Ph.D. (Leeds), F.L.S., F.N.I., Director, Jute Agricultural Research Institute, Hooghly.

KUPPUSWAMY, B., M.A., D.Litt., Lecturer in Psychology, University of Mysore, V. V. Mohalla P.O., Mysore.

KURIYAN, George K., Research Assistant, Marine Biological Station, Krusadai Island, Pamban P.O., Ramnad Dist.

KURULKAR, Ganesha Madhab, M.B.B.S., Asst. Professor of Anatomy, Seth Gordhandas Sunderdas Medical College, Bombay 28.

KUTAR, P. H., B.A., B.Sc. (Hons.), M.S., Met.E. (U.S.), General Superintendent, Tata Iron & Steel Co., Ltd., Jamshedpur.

L

LACY, R. C., Head of the Department of Botany, Science College, Patna.

LAHIRI, D. C., Asst. Director, Department of Antitoxins & Sera, Haffkine Institute, Parel, Bombay 12.

LAKSHMANAN, T. K., M.A., M.Sc., L.T. Additional Professor of Physics, Presidency College, Madras 5.

LAL, K.B., M.Sc., Ph.D. (Edin.), Entomologist to Govt., U.P., Kanpur.

LAL, Ram Bihari, M.B.B.S., D.B.H., D.T.M.&H., D.B., F.N.I,, Professor of Epidemiology and Vital Statistics, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

LAROIA, B D., B.A., (Oxon.), Ph.D., D.I.C. (Lond.), Officer-in-Charge, Central Medical Laboratory, Old Viceregal Lodge, Delhi.

LASKAR, B., A.I.S.M., Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

LATIF, Israil, M.A., Ph.D., Head of the Department of Psychology and Director, Child and Youth Guidance Clinic, Forman Christian College, Lahore.

LAW, Nirmal Chandra, M.Sc., 50, Kailas Bose Street, Calcutta.

LAW, Satya Churn, M.A., B.L., Ph.D., F.Z.S., F.N.I., M.B.O.U,, 50, Kailas Bose Street, Calcutta.

LEVI, F. W., Dr. Phil.Nat, Professor of Tatar Institute of Fundamental Research 53, Pedder Road, Bombay.

LIKHITE, Vishwanath Narayan, D.Sc., Deputy Director of Agriculture, "Deepak", 32, Alakapuri, Baroda.

LIMAYE, S. D., Ph.D, Director, The Ranade Industrial and Economic Institute, Poona 4.

*LOOMBA, Ramamurti, Lecturer in Philosophy, Lucknow University, Lucknow.

LUTHRA, Jai Chand, Rai Bahadur, I.A.S., Principal, Central College of Agriculture, P.O. Anand Parbat, Karobbagh.

M

MACMILLAN, William George, Ph.D. (Cantab), F.I.C., Chief Chemist, Indian Jute Mills Association, Research Institute, 16, Old Court House Street, Calcutta.

MADHAVA, K. B., M.A., A.I.A. (Lond.), F.N.I., Professor of Statistics, Andhra University, Waltair.

MAHABALE, T. S., B.A., M.Sc., Ph.D., Assistant Editor, 'Dictionary of Economic Products and Resources of India,' Council of Scientific and Industrial Research, 20, Rusa Road, Karolbagh, New Delhi.

MAHADEVAN, C., M.A., D.Sc., F.A.Sc., F.N.I., Head of the Department of Geology, Andhra University, Erskine College of Natural Sciences, Waltair.

MAHAJAN, L. D., M.Sc., Ph.D., F.Inst.P. (Lond.), Professor and Head of the Physics Department, Mahendra College, Patiala. (State).

MAHALANOBIS, P. C., O.B.E., F.R.S., M.A. (Cantab), B.Sc. (Cal.), F.N.I,, I,E,S,, Statistical Laboratory, Presidency College, Calcutta.

MAHALANOBIS, S. C., F.R.S.E., I.E.S. (Retd.), Emeritus Professor of Psychology and Fellow of the University of Calcutta, 210, Cornwallis Street, Calcutta.

MAHALANOBIS, Sujit Kumar, M.Sc., Demonstrator of Physiology, Carmichael Medical College, Calcutta.

MAHANTI, P. C., D.Sc., F. Inst. P., F.N.I., Assoc. A.I.E.E., Dept. of Applied Physics, University College of Science, 92, Uppeer Circular Road, Calcutta.

MAHARASTRA Sugar Mills, Ltd., The Industrial Assurance Building, Opposite Churchgate Station, Fort, Bombay.

MAHENDRA, Beni Charan, Professor of Zoology, Birla College, Pilani, Jaipur State.

MAHESWARI, Panchanan, D.Sc., F.N.I., Head of the Department of Biology, Dacca University, Dacca.

MAITI, Haripada, M.A., Professor and Director of Applied Psychology, Patna University, Patna.

MAITRA, B., M.Sc., F.C.S., Director, Calcutta Chemical Co. Ltd., 35, Panditia Road, Calcutta.

MAITRA, J. N., M.Sc., M.B., D.T.M., D.H.M. (Cal.), 1, Corries Church Lane, Amherst Street, P.O., Calcutta,

MAITRA, Susilranjan, M.Sc., Department of Physiology, University College of Science, 92, Upper Circular Road, Calcutta.

MAJUMDAR, D. N., M.A., P.R.S. (Cal.), Ph.D. (Cantab), F.R.A.I., F.N,I,, Reader in Anthropology, Lucknow University, Lucknow.

MAJUMDAR, G. G., M.Sc., Ph.D., 187, Kesaba Peth, Poona 2.

MAJUMDAR, Girija, Prasana, M.Sc., Ph.D., F.N.I., Professor of Botany, Presidency College, Calcutta.

MAJUMDAR, K., D.Sc., Physics Department, University of Allahabad, Allahabad.

MAJUMDAR, R. C., Dr.Phil.Nat., Associate Professor of Physics, Delhi University, Delhi.

MALHOTRA, D. R., Chief Chemist and Metallurgist, B.B. & C.I.Ry., Ajmer.

MALLIK, A. K,. M.Sc., Meteorologist, Mateorological Office, Poona 5.

MANAGER, M. P. Sugar Mills Co., Ltd., P.O. Majhaulia, R. S. Champaran.

MANDAL, Benoy, B.Sc. (Wales.), C.D.D. (Aberystwyth.), P.O. Jadavpur College, 24, Parganas.

MANDAL, Kanai Lal, D.Sc., Chemical Laboratory, Presidency College, Calcutta.

MANDAL, Kanai Lal, D.Sc., Professor of Chemistry, City College Calcutta.

MANGALIK, Vanmali Sharan, M.D., D.C.P. (Lond.), Reader in Pathology, King George's Medical College, Lucknow.

MANJUNATH, B. L., B.A., M.Sc. (Lond.), D.Phil. (Oxon.), Chief Editor, 'Dictionary of Economic and Resources of India' 20, Pusa Road, Karol Bagh, Delhi.

MANSINGGH, Bishan, B.A., Zaminder and Farmer, The Man Bhavan, Fatehpur, U.P.

MASANI, Nariman Adarji, M.A., B.Sc., Technical Chemist, Petitt Mansions, Sleater Road, Bombay 7.

MASON (Miss) Eleanor D., M.A., Ph.D., Professor of Nutrition and Physiology, Women's Christian College, P.O. Cathedral, Madras.

MATHEW, M. J., M.Sc., Research Assistant, Madras Government Fisheries, Tungabhadra Project, Hospet, Bellary.

MATHEW, N. T., M.A., M.Sc., Superintending Statistician, Indian Statistical Institute, Presidency College, Calcutta.

MATHUR, G. D., M.A., M.Sc., Statistical Research Officer, Office of the Economic Adviser, Government of India, New Delhi.

MATHUR, Har Govind Dayal, M.B., M.R.C.P.E., Dr. P.H., Secretary, Medical Council of India, Connaught Circus, New Delhi.

MATHUR, K. N., D.Sc., Assistant Director, Council of Scientific & Industrial, National Physical Research, Imperial Secretariat, North Bloc, New Delhi.

MATHUR, N. P., Civil Engineer, Lucknow University, Lucknow.

MATHUR, R. N., M.Sc., Assistant Entomologist, Forest Research Institute, Dehra Dun.

MATHUR, S. B. L., Physics Dept., Lucknow University, Lucknow.

MATHUR, S. N., M.B.B.S., Ph.D. (Lond.), Professor of Physiology, Medical College, Lucknow.

MAZUMDAR, A. K., B.Sc., Assistant Chemist, Geological Survey India, 27, Chowringhee, Calcutta.

MAZUMDAR, Benoy Kumar, D.F.A., A.M.I.E.E., Executive Engineer, Central Public Works Dept., 19, Sanat Chatterjee Avenue, Calcutta 29.

MAZUMDAR, K. C., The New Control Research Laboratory, Tata Iron & Steel Co., Ltd., P.O. Tatanagar, B. N. Ry.

MEHRA, H. R., M.Sc., Ph.D. (Cantab), Reader in Zoology, Allahabad University, Allahabad.

MEHTA, B. N., M.Sc., A.H.B.T.I., Public Health Chemist, Pratapganj, Baroda.

MEHTA, J. K., B.E. (Civil), A.M.I.E. (Ind.), C/o. M/s. Duncan Stratton & Co., Ltd., 5, Bank Street, P.O. Box No. 64, Bombay 1.

*MEHTA, Jivraj Narayan, M.D., (Lond.), M.R.C.P. (Lond.), L.M. & S. (Bom.), F.C.P.S. (Bom.), Physician, Khambutta Hall, 16, Altamont Road, Cumbulla Hill, Bombay 26.

MEHTA, K. C., Rai Bahadur, M.Sc., Ph.D., F.N.I., Professor of Botany, Agra College, Agra, U.P.

MEHTA, K. M., M.Sc., Assoc. I.A.R.I., Public Analyst, Public Health Department, Jodhpur.

MEHTA, (Miss) Maneck M., M.A., M.Sc. (Bom.), D.Sc., Ph.D. (Lond.), F.I.C., D.I.C., Khambatta House, 193, Lawington Road, Bombay 7.

*MEHTA, P. I., C/o. Minerva Dyes & Chemicals Co., Inside Khanstate, opp. Pande Dharmashala, 262, Thakurdwar Road, Bombay 2.

MEHTA, S. M., B.A., M.Sc., A.I.C., Lecturer in Inorganic Chemistry, Royal Institute of Science, Mayo Road, Bombay.

MEHTA, T. H., Dy. Vice-Principal, Govt. Polytechnic, Kashmere gate, Delhi.

MENON, C. Gopal, Geologist, Associated Cement Co., Ltd., Fort, Bombay.

MENON, I. G. K., D.Sc., Asst. Director, Pastur Institute, Coonoor (S. India).

MENON, K. P., L.R.C.P.&S. (Edin.), 1, Viviani Road, Richards Town, Bangalore.

MENON, K. P. P., B.Sc., A.M.I.E., C|o., Aluminium Mfg. Co., Ltd., 2, Jessore Road, Dum Dum.

MENON, T. K. N., B.A., T.D. (Leeds & Berlin), M.A.Ed. (Leeds), Principal, Secondary Teachers' Training College, Editor, Journal of Education and Psychology, Sayagiganj, Baroda.

*METRE, W. B., Geologist, B. O. C. (I. C.) Ltd., P.O. Digboi, Assam.

MILITARY Veterinary Laboratory, Lahore Cantonment.

Ministery of Food, Government of India, New Delhi.

MIRCHANDANI, T. J., M.Sc., Ph.D. (Lond.), Agricultural Chemist and Sail Physicist, Agricultural Research Station, Sakrand (Sind).

MIRCHANDANI, U. M., I.C.S., Commissioner, N. D., Shahibagh, Ahmedabad 4.
MISRA, A. B., D.Sc., D.Phil., Head of the Department of Zoology, Benares Hindu University, Benares.
MISRA, M. L., M.A., Prof. and Head of the Department of Mathematics, Maharana College, Udaipur, (Rajputana).
*MISRA, Ramadhar, M.A., Ph.D. (Edin.), Reader in Mathematics, Lucknow University, Lucknow.
*MISRA, Ramdeo, M.Sc., Ph.D. (Lond.), Reader and Head of the Botany Department, University of Saugar, Saugar, C.P.
MISRA, R. A. P., Indian Wild-Barfield Co., Ltd., Fort Chambers, 6|10, Dean Lane, Hammam Street, Fort, Bombay.
MISRA, R. C., M.Sc., F.G.M.S., Ph.D., Department of Geology and Botany, Lucknow University, Lucknow.
MISTRY, S. M., M.Sc., A.I.I.Sc., 84, Sion Road, Sion Bombay 22.
MITRA, (Miss) Abha, Prof. of Mathematics, Patna Women's College, Patna.
MITRA, A. K., Ph.D., Lecturer in Botany, 22, K. P. Kakkar Road, Allahabad.
MITRA, Anil Chandra, M.A., B.L., Managing Director, International Tyres & Motors Ltd., 2, Rowland Road, Calcutta 20.
MITRA, Girija Bhushan, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta 12.
MITRA, Himansu K., M.Sc. (Cal.), Ph.D., (Pittsburg), M.I.Cer.E. (U.S.A.), Refactories Engineer, Tata Iron & Steel Co., Ltd., 12-A, Road East, Jamshedpur.
MITRA, Kalidas, M.B.E., M.B., D.P.H. (Cal.), D.T.M. & H. (Eng.), F.S,S, (Lond,), Office of the Director-General of Health Services, Central Government, New Delhi.
MITRA, Ram Prasad, D.Sc., Department of Chemistry, Delhi University, Delhi.
MITRA, S. K., M.B.E., D.Sc. (Cal. & Paris), F.N.I., Sir Rashbehary Ghosh Professor of Physics, University College of Science, 92, Upper Circular Road, Calcutta.
*MITRA, S. K., Rai Bahadur, M.Sc., Ph.D., I.A.S. (Retd.), Agricultural Adviser Eastern State Union, Balangir, Patna State.
MITRA, Suhrit Chandra, M.A. (Cal.), Dr. Phil. (Leipzig), Lecturer, Psychology Department, University College of Science, 92, Upper Circular Road, Calcutta.
MITTER, A., M.Sc., Geological Survey of India, 27, Chowringhee, Calcutta.
MITTER, G. C., O.B.E., M.Sc., F.R.I.C., F.N.I., Chief Technical Adviser (Mints), Bombay.
MITTER, P. C., M.A., Ph.D., F.N.I., 22, Garpar Road, Calcutta.
MODAK, N. V., B.E., M.I.C.E., M.I.E. (Ind.), M.I.M. & Cy,E,F,R,San,I,,Ac,,J,P City Engineer, Bombay Municipality, Bombay.
MODI, D. F., B.Sc., Head of the Electrical Department, William Jacks & Co. Ltd., 10, Clive Street, Calcutta.
MOGHE, M. A., M.A., M.Sc., Ph.D. (Lond.), Head of the Department of Zoology, College of Science, Nagpur.
MOHAN, A. R., Associated Cement Co. Ltd., P.O., Sind Cement Works, Via-Rohri, (Sind).
MOHURY, Bipra Das, Civ. Eng., M.Soc. C.E., (France), A.M. Inst. H. E., A.I.A.E., A.M.A.E. (India), Civil Engineer, The Concrete Association of India, Victoria House, Calcutta.
MOOKERJEE, Himadri Kumar, M.Sc., (Cal), D.I.C., D.Sc. (Lond.), F.N.I., Sir Nilratan Sircar Professor and Head of the Department of Zoology, Calcutta University, 35, Ballygunge Circular Road, Calcutta.
MOOKERJEE, R. P., M.A., B.L., 77, Asutosh Mookerjee Road, Bhowanipore, Calcutta.

Mookerjee, Sitansu, M.A., Head of the Dept. of Geography, Nagpur University Morris College, Nagpur.

Mookerjee, Sivatosh, B.Sc, 77, Asutosh Mookerjee Road, Calcutta.

Mooney, H. F., C.I.E., O.B.E., I.F., Sambalpur, Orissa.

Moses, S. T., M.A., D.Sc., F.Z.S., F.R.A.I., Director of Fisheries, Baroda State, Baroda.

Motwani, Kewal, A. M., Ph.D., C/o. Post Master, Pusa Institute, New Delhi.

Moudgill, Kishori Lal, M.A. (Cantab), D.Sc., F.I.C., Director of Research, University of Travancore, Trivandrum.

Mozumdar, M., B.S.E. (Mich.), M.S. (Ill.), Mg. Agnt. Tropical Accumulaters Ltd., 32-B, Mahim Halder Street, Calcutta.

Mukerjee, P. N, M.Sc., (Lond.), D.I.C., Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

Mukerjee, Umadas, M.Sc., Professor and Head of the Department of Physics, College of Science, Nagpur.

*Mukerji, B., D.Sc, M.D., M P S., F.A.Ph S., F.N.I., Director, Biochemical Standardization Laboratory, Government of India, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

Mukerji, B. N., M.Sc, Ph D, (Edin), Head of the Department of Geography, Calcutta University, Senate House, Calcutta.

Mukerji, Durgadas, M.Sc., Department of Zoology, University College of Science, 35, Ballygunge Circular Road, Calcutta.

Mukerji, H. M., M.Sc., D.Sc. (Lond), D I C., Special Officer, Manurial Scheme, Salimpur Ahara, P.O. Kadamkuan, Patna.

Mukerji, S. N., M.Sc., A.M.I.E., Assistant Director (Electrical), Government Test House, Alipore, Calcutta.

Mukherji, S. N., West End. Watch Co., 16, Old Court House Street, Calcutta.

Mukerji, Subodh Ch., M.B., 60-1, Harrison Road, Calcutta.

Mukherjee, Bankim, M.M.F, (Bengal), L.D.S., R.C.S., (Eng.), Clinical Dental Tutor, Medical College Hospital, Calcutta.

Mukherjee, Dibakar, M.Sc., Chemist-in-Charge, Research Laboratory, Baranagore Jute Factory Co., Ltd., P.O. Alambazar, 24-Parganas.

Mukherjee, G. C., Professor, Engineering College, Hindu University, Benares.

Mukherjee, J. N., C.B.E., D.Sc. (Lond.), F.C.S., F.R.A.S.B,, F,N,I,, Director, Indian Agricultural Research Institute, New Delhi.

Mukherjee, M. K, M.Sc., Ph.D., Post Box 10007, Calcutta.

Mukherjee, S., D.Sc., Division of Entomology, Indian Agricultural Research Institute, New Delhi.

Mukherjee, S. K., M.Sc., B.L., Assistant Superintendent, H.E.H., the Nizam's Geological Survey, Jeera Compound, Secunderabad, Deccan.

Mukherjee, S. N., M.Sc., Professor of Physical Chemistry, College of Engineering and Technology, Bengal, P.O. Jadavpur College 24 Parganas.

Mukherjee, S. N, Sectional Officer, C.P.W.D., 14, Madan Street, Calcutta.

Mukherjee, S. S., District Engineer, B. N. Ry., B. N. Ry. House, Kidderpur, Calcutta.

Mukherjee, Sudhamoy, M.Sc., Bengal Immunity Research Institute, 39-B, Lower Circular Road, Calcutta 16.

Mukherjee, Sardar A. T., M.Sc., Secretary, Primary and Rural Education Committee, All India Federation of Educational Associations, Nabadwip, (Bengal).

Mukherji, R. G., M.Sc., M.A.I.E.E., A.M.I.E.E. (Lond.), Electrical Executive Engineer, 34, Ghose Lane, Calcutta-6.

Mukherji, K. C., M.A., P.R.S., Lecturer in Psychology, University College of Science, 92, Upper Circular Road, Calcutta.

Mulay, L. N., M.Sc., Staff Quarter, Dharwar.

Mullick, D. N., Ph.D., Animal Nutrition Section, Indian Veterinary Research Institute, Izatnagar, Bareilly (U. P.).

Mulye, Bhalchandra D., M.B.B.S., Sakkar Bazar, Indore City, Central India.

Mundkur, B. B., M.A., Ph.D., F.N.I., Deputy Director (Plant Division), Directorate of Plant Protection, Ministry of Agriculture, New Delhi.

Mungavin, J. M., M.B.B.Ch., Imperial Chemical Industries (India) Ltd., Medical Service Dept., 18, Strand Road, Calcutta.

Munigaviappa, M., Research Fellow, Department of Mathematics, Central College, Bangalore.

Munsi, Nihar Kumar, M.B. (Cal.), D.O.M.S. (Lond.), 55, Creek Row Calcutta.

Murthy, L. S., Krishna, B.Sc., Petrologist, Geological Survey, Hyderabad-Deccan.

Murty, G. V. L. N., D.Sc., Research Chemist, Research Laboratory, Tata Iron & Steel Co., Ltd., Tatanagar.

Muthuswami, T. N., M.A., L.T., Professor of Geology, Presidency College, Triplicane, Madras.

Mysore Sugar Company Ltd., The Secretary, Sri Jayachamaraja Wadayar Road, Bangalore City.

N

Nabar, G. M., M.Sc. (Ecch.), Ph.D. (Manch.), B.A., M.Sc., (Bom.), Department of Chemical Technology, University of Bombay, Matunga, Road, Bombay 19.

Nabar, J. A., M.Sc., LL.B., Professor of Chemistry, Wilson College, Bombay 7.

Nabar, P. M., B.A., B.Sc., Tech. (Manchester), A.R.I.C., Chief Advisory Chemist. Office of the Director-General, Indian Medical Service, Imperial Secretariat, North Block, New Delhi.

Nag, N. C., M.A., F.I.C., 18/28, Dover Lane, Calcutta.

Nagappa, Y., M.Sc., C|o, The Burmah Oil Co., Ltd., 11, Gurusadaya Road, Calcutta.

Nagar, D. S., Asst. Cane Agriculturist, Kotai, Aligarh.

Naidu, P. S., M.A., University Reader in Education, Allahabad University, Allahabad.

Naik, K. G., M.A. (Bomb.), D.Sc. (Lond.), F.I.C., F.N.I., Principal, L. D, Arts College, Ahmedabad.

Naik, R. N., G.B.V.C., Bacteriologist, Bombay Veterinery College, Parel, Bombay 12.

Nair, P. V., M.Sc., D.Phil. (Oxon.), Professor of Applied Chemistry, Central Research Institute, Trivandrum.

Nair, U. S., Ph.D., Head of the Department of Statistics, Travancore University, Trivandrum.

Nandi, B. L., M.Sc., Ph.D., D.I.C., A.I.C., 52, Shambhunath Pandit Street, Calcutta.

Nandi, Hari Kinkar, M.Sc., Lecturer, Department of Statistics, Calcutta University, Asutosh Building, Calcutta.

Nandi, P. N., Section of Microbiology, Bose Research Institute, 93, Upper Circular Road, Calcutta.

Nandi, R. D., 2A, Lansdowne Road, Calcutta 29.

Nandi, S. K., M.Sc., A.R.I.C., Lecturer in Chemical Engineering, Indian Institute of Science, Malleswaram P.O., Bangalore.

Narayan, A. L., M.A., D.Sc., F.I.P., 1, Maharani Road, Madras 18.

Narayan, B. T., Ph.D., Deputy Director of Agriculture, Department of Agriculture, (Govt. of Mysore) Seshadri Road, Bangalore.

NARAYANA, Basudeva, M.Sc., M.B., Ph.D., F.R.S.E., Principal, P. W. Medical College, Bankipore, Patna.

NARAYANAN, E. S., M.A., Ph.D. (Lond.), D.I.C. (Lond.), F.R.E.S., Head of the Department of Entomology, Indian Agricultural Research Institute, New, Delhi.

†NARIMAN, R. K., A.C.H., M.I.C.E., M.Am.Soc. C.E., F.R,G,S,, M,R,B,S,, M,R,S,A: M.A.C. & A.E., M.I.E. (Can.), P.O. Box 13, Bombay.

NARLIKAR, V. V., B.Sc., (Bom.), B.A. (Cantab), F.R.A.S., F.N.I., Head of the Department of Mathematics, Benares Hindu University, Benares.

NARRONDAS Monordass Institute of Science, Bharatiya Vidya Bhavan, Chowpatty Road, Bombay 7.

NARWANI, C. S., M Sc., 18, Shrimali Society, Naurangura, Ahmedabad.

NATARAJAN, C. V., B.Sc., M.B. & B.S., Dr. P.H., Superintendent, Public Health Institute, Bangalore.

NATH, M. C., D.Sc., Professor and Head of the Department of Bio-chemistry, University of Nagpur, Nagpur.

NATH, N. S. Nagendra, M.Sc., Ph.D. (Cantab), Professor of Mathematics, Science College, Patna.

NATH, Ram, M.Sc., C/o. Agricultural Chemist to U.P. Government, Kanpur, (U.P.). Bombay 1.

NATH, Vishwa, M.Sc., Ph.D. (Cantab), F.N.I., Principal, Government College, Hoshiarpur, (East Punjab).

NAVALKAR, B. S., M.Sc., Ph.D., Assistant Lecturer in Botany, Royal Institute of Science, Bombay 1.

NAYAR, A. S. Mannadi, M.B.B.S.. Ph.D. (Edin.), Professor of Biochemistry, Medical College, Madras.

NAYAR, A. S. Mannadi, M.B. & B.S., Ph.D. (Edin.), Professor of Biochemistry, Medical College, Madras.

NAYAR, K. Karunakaran, M.A., Ph.D., Lecturer in Zoology, University College, Trivandrum.

NAYAR, M. Raman, Lecturer in Chemistry, Lucknow University, Lucknow.

NEGI, P. S., M.Sc., Acting Entomologist, Indian Lac Research Institute, Namkum, Ranchi.

NEHRU, Jawaharlal, 17, York Road, New Delhi.

NELLAYANDAR, M., B.Sc. (Hons.), Research Assistant, Fisheries Rech. Station, Ennur (Near Madras).

NEOGI, Hirendra Nath, M.Sc., Post Box No. 216, Rangoon, Burma.

NEOGY, Dhruba Lal, Hony. Lt. Commander R.I.N.R. A.M.I.E.S. (Seat), A.M.I.M.A,R,E, (Lond.), Marine Supdt.'s Bungalow, "Riverside," P.O. Pandu, Dist. Kamrup,

NIMALASURIA, Ananda, M.B.B.S., M.R.C.P. (Lond.), Medical Officer, Bacteriological Institute, Colombo, Ceylon.

NIRULA, R. L., B.Sc., Ph.D. (London), D.I.C., Head of the Department of Botany, College of Science, Nagpur.

NIYOGI, B. B., B.Sc., F.R.I.C., Lecturer in Chemistry, Indian School of Mines, Dhanbad.

NIYOGY, S. C., Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

NIZAM Sugar Factory Ltd., The Shakarnagar, via Nizamabad, Hyderabad-State, Deccan.

NORTH Bengal Sugar Mills Co., Ltd., 8, Dalhousie Square East, Calcutta.

O

OBSERVATORIES, The Director-General of The Observatory, Lodi Road, New Delhi
*OLPADVALA, E. S., 52, Chowringhee Road, Calcutta.

PADMANAVAN, S. Y., Mycologist, C. R. R. Institute, P.O. Nayabazar, Cuttack.

PAL, B. P., M.Sc., Ph.D. (Cantab), F.L.S., Indian Economic Botanist, Indian Agricultural Research Institute, New Delhi.

PAL, Gopeswar, D.Sc., Lecturer, Department of Psychology, University College of Science, 92, Upper Circular Road, Calcutta.

PALIT, Santi R., 49-1A, Tallygunge Road, Kalighat P.O., Calcutta.

PANDE, Chandra Shekhar, M.Sc., Chemistry Dept., Lucknow University, Lucknow.

PANDE, S. K., D.Sc., Lecturer in Botany, Lucknow University, Lucknow.

PANDIT, C. G., M.B.B.S., Ph.D., D.P.H., D.T.M., F.N,I,, Director, King Institute, Guindy, P.O., Saidapet, Madras.

PANDYA, Anant H., Sc.D. (Eng.), A.M.Am.Soc.C.E., A.M.I., Struct. E., A,M,I,E,, A,M, Inst. W., 12, Raja Santosh Road, Alipore, Calcutta.

PANDYA, K. C., M.A., Ph.D., D.I.C., Professor of Chemistry, St. John's College, Shantikunja, Bag Muzaffarkhan, Agra.

*PANIKKAR, N. Kesava, M.A., D.Sc., University Zoological Laboratory, Chepauk, Triplicane P.O., Madras.

PANJA, D., M.B. (Cal.), Medical Mycology Enquiry, School of Tropical Medicine, Calcutta.

PANJA, G., M.B. (Cal.), D.B. (Lond.), F.N.I., Professor of Bacteriology and Pathology, Calcutta School of Tropical Medicine, Calcutta.

PANT, Bunshidhar, 106|74, Gandhinagar, Kanpur.

PARAMESWARAN, H., M.A., Ph.D., D.Sc., F.Inst.P., Xanadu, Trivandrum.

PARANJPE, Gopal Ramchandra, M.Sc., A.I.I.Sc., F.N.I., O.B.E., I.E.S. (Retd,) 'Sudarshan,' 202-1, Sadasiva Road, Poona 2.

PARANJPE, (Miss) Maina M., M.Sc., Ph.D., D.I.C., Assistant Lecturer, Royal Institute of Science, Mayo Road, Bombay 1.

PARIJA, P., O.B.E., M.A. (Cantab), F.N.I., I.E.S., Vice-Chancellor, Utkal University, Cuttack.

PARIKH, H. P., M.Sc., Excise Chemist, Technological Institute, Excise Laboratory, Baroda.

*PARKER, R. N., F.C.H., C/o. Thos. Cook & Sons, Cape Town, S. Africa.

PARTHASARATHI, Sri A., B.Sc. (Hons.), Asst. Prof. of Geology, Presidency College, Triplicane, Madras 5.

PARTHASARATHY, N., B.A., B.Sc., Ph.D. (Lond.), Second Cane Breeding Officer, Indian Agriculture Research Institute, Lawley Road, Coimbatore.

*PASRICHA, B. R., M.Sc., Professor of Mathematics, I. T. College, Lucknow.

PATEL, B. V., B.Sc., B.Pharm. (Lond.), Ph.C., Asst. Director, Dept. of Pharmacology, Haffkine Institute, Bombay 12.

PATEL, *Chaturbhai Shankarbhai*, B.A., M.Sc., Ph.D., Director of Technological Institute and Industrial Chemist, Baroda State, Baroda.

PATEL, J. P., C/o. The Patel Brothers, Patel House, 10, Churchgate Street, Fort, Bombay

PATEL, J. S., Ph.D., Principal, Bihar Agriculture College, Sabour P.O., Bhagalpur.

PATEL, M. D., M.Sc., Ph.D., Director and Secretary, Institute of Agriculture, Anand.

PATEL, M. S., Ph.D., (Cantab), C/o. Mr. P. G. Bhutta, Plot No. 44A, Tilak Road, Santa Cruz, Bombay 23.
PATEL, R. P., M.Sc., Ph.D. (Lond.), Principal, Lallubhai Motilal College of Pharmacy, Ahmedabad 9.
PATEL, T. D., M.B.B.S., Blood Processing Unit, Haffkine Institute, Bombay 12.
PATIL, H., 32, Lady Hardinge Road, New Delhi.
PATWARDHAN, K. A., Daly College, Indore.
PATWARDHAN, Narayan Keshava, M.Sc., Ph.D., Senior Scientific Officer, Building Research Unit (C.S.I.R.), Roorkee.
PATWARDHAN, V. N., Director, Nutrition Research Laboratories Indian Research Fund Association, Coonoor.
PAUL, G. B., B.Sc. (Edin.), C/o. Jessop & Co., Dum Dum.
PAUL, P., B.Sc., B.E., Sub-Divisional Officer, C.P.W.D., 14, Madan Street, Calcutta.
PHADKE, (Miss) Ragini, 4A, Siri Road, Malabar Hill, Bombay 6.
PHALNIKAR, M. L., M.Sc., Ph.D., A.R.I.C., S. P. College, Poona 2.
PICHAMUTHU, C. S., B.Sc., Ph.D. (Glas.), F.R.S.E., F.G.S., F.A,Sc,, F,N,I,, Principal, Intermediate College, Bangalore.
PILLAY, T. V. R., B.Sc., Assistant Director of Fisheries, Port Okha (Baroda State), Kathiawar.
PITHAWALLA, Maneck B., D.Sc., B.A., L.C.P., F.G.S. (Lond.), M.R.A.S, (Lond,), M.R.S.T. (Lond.), Bombay University Teacher in Geography for Post-Graduate Students and Professor of Geology, N.E.D. Engineering College, Karachi.
PODDAR, M., A.I.S.M., Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
PRABHAT Film Co., Prabhatnagar, Poona 4.
PRADHAN, S., M.Sc., Ph.D. (Lond.), D.Sc. (Luck.), F.R.E.S., Insect Toxicologist, Division of Entomology, Indian Agricultural Research Institute, New Delhi.
PRAKASH, Prem, M.Sc., Physical Laboratories, Council of Scientific & Industrial Research University Buildings, Delhi.
PRAKASH, Satya, D.Sc., Lecturer in Chemistry, University of Allahabad, Allahabad.
PRAMANIK, S. K., M.Sc. (Luck.), Ph.D. (Lond.), D.I.C., Meteriological Office, Ganeshkhind Road, Poona.
PRANAVANANDA, (Rev.) Swami, (of the Holy Kailas and Manosarovar), C/o. Messrs, Laxmilal Ananda Bros., P.O., Almora, U.P.
PRASAD, B., Principal, Bihar College of Engineering, P.O., Mahendra, Patna.
PRASAD, B. N., D.Sc., (Paris), Ph.D., (L'pool), F.N.I., Lakshminiwas, George Town, Allahabad.
PRASAD, B. N., F.R.S.E., Ph.D. (Edin.), M.Sc., M.B., D.T.M, (Cal,), Professor of Pharmacology, P. W. Medical College, Bankipore, Patna.
PRASAD, Balbhadra, D.Sc. (Lond.), Professor of Chemistry, Ravenshaw College, Cuttack.
PRASAD, Mata, D.Sc., (Benares), F.N.I., Professor of Inorganic and Physical Chemistry, Royal Institute of Science, Fort, Bombay.
PRASAD, M. S., M.Sc., New Asiatic Insurance Co., Ltd., Brajkishore Peth, Patna.
PRASHAD, Baini, O.B.E., D.Sc., F.R.S.E., F.L.S., F.Z.S., F,R,A,S,B,, F,N,I, C/o Department of Planning and Development, Government of India, Imperial Secretariat, New Delhi.
PUBLIC Health, Director, Holkar State.
PUNTAMBEKAR, S. V., M.Sc., Ph.D., Senior Research Chemist, Forest Research Institute, Dehra Dun, U.P.
PURI, G. S., D.Sc., Ecologist, Forest Research Institute, Dehra-Dun.
PURI, V., D.Sc. (Agra), Head of the Biology Department, Meerut College, Meerut.
PURI, V., D.Sc., (Agra), Head of the Biology Department, Meerut College, Meerut.

Q

QAZILBASH, Nawazish Ali, Professor of Botany, Islamia College, Peshawar.

R

RACINE, C., S.J., D.Sc. (Paris), Professor of Mathematics, Loyola College, P.O. Cathedral, Madras.

RAGHAVAN, O. T., B.A., B.E. (Civil), A.M.I.E. (Ind.), Executive Engineer, Water Supply Corporation of Madras, P. T. Madras.

RAGHAVAN, M. D., Entomologist and Asst. Director, Department of National Museums of Ceylon, Colombo (Ceylon).

RAHMAN, S. A., Professor of Physiology, Medical College, Mohalla Lingumpally, Hyderabad-Deccan.

RAI, R. N., Lecturer in Physics, Delhi University, Delhi.

*RAJ, B. Sundara, Diwan Bahadur, M.A., Ph.D., F.N.I., Fisheries Development Officer, U.P., 1, Olliver Road, Lucknow.

RAJ, (Miss) Hilda, Dept. of Anthropology, University of Delhi, Delhi.

RAJA, K. C. K. E., Rai Bahadur, O.B.E., 2, Old Mill Road, New Delhi.

RAJAGOPAL, K., M.Sc., M.B.B.S., Major, Associate Professor of Biochemistry, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

RAJAGOPALASWAMI, Kurma, M.A., (Cantab), Geologist to the Associated Cement Companies Ltd., Esplanade House, Fort, Bombay.

RAJALAKSHMAN, D. V., M.A., M.Sc., Lecturer in Statistics, University of Madras, Triplicane P.O., Madras.

RAJDERKAR, E. B., M.Sc., Industrial Physicist, Commissariat Building, Hornby Road, Fort, Bombay 1.

RAJENDRAN, A. T. Isac., B.Sc. (Hons.), Research Assistant, Marine Biological Station, Tuticorin.

RAJGARHIA, Chand Mull, Giridih.

RAJNATH, M.Sc., D.I.C., Ph.D. (Lond.), F.N.I., Professor and Head of the Department of Geology, Benares Hindu University, Benares.

RAJU, S. P., B.A., B.E., M.I.E. (Ind.), Dr. Ing. (Munich), Professor of Hydraulic Engineering, Engineering College, Osmania University, Hyderabad-Deccan.

RAKSHIT, H., D.Sc., F.Inst.P., F.N.I., Lecturer in Applied Physics, University of Calcutta, Calcutta.

RAKSHIT, N. N., Chief Engineer, Tatanagar Foundry Co., Tatanagar, B. N. Ry.

RAM, Pars, Capital Industries, Serai Rohilla, Delhi.

RAMAN, G. A., B.Sc., F.R.I.C., Officer on Special Duty, Goodlass Wall (India) Ltd., Fergusson Road, Lower Parel, Bombay 13.

RAMANATHAN, K. R., Diwan Bahadur, M.A., D.Sc., F.N.I., Offg. Director General of Observatories, Lodi Road, New Delhi.

RAMANATHAN, V., Retd., Deputy Director of Agriculture, Nambedu, Mel Nemili P.O., Via Arui.

RAMANUJAM, S., M.A., Ph.D., Director, Central Potato Research Institute, New Delhi.

RAMASWAMI, L. S., Department of Zoology, Intermediate College, Mysore.

RAMCHANDRA, R. B., M.A., 18, Rajpur Road, Civil Lores, Delhi.

RAMDAS, L. A., M.A., Ph.D., F.N.I., Agricultural Meteorologist, Meterological Office, Poona, 5.

RAMIAH, K., M.B.E., M.Sc., Dip.-Agri. (Cantab), L.Ag., Director, Central Rice Research Institute, Chauliaganj, Cuttack.

RANADE, Shridhar Balkrishna, B.A., M.Sc., Lecturer in Biology, 435, Bhagwat Bunglow, '15, Road, Khar, Bombay.

RANADE, V. V., 101, Shukarwar, Peth, Poona 2.

RANDHAWA, M. S., M.Sc., I.C.S., F.N.I., 17, Rajpur Road, Delhi.

RANJAN, Shri, M.Sc., (Cantab), Docteur-es-Sciences, F.A.Sc., Department of Botany, Allahabad University, Allahabad.

RAO, A. R., Aswatha Narayana, D.Sc., Lecturer in Colloid Chemistry, Indian Institute of Science, Bangalore.

RAO, A. Madhava, M.Sc., Chemist, M|S. Parry and Co., Ltd., Ranipet, (S. India).

RAO, A. Narasinga, M.A., L.T., D.Sc., F.A.Sc., Head of the Department of Mathematical Physics, Andhra University, Waltair.

RAO, A. R. Narayana, Rao Sahib, B.E., Mech., A.M.I.E.E., Superintending Engineer, Government Electricity Department, Metturdam, Madras.

RAO, B. Rama, M.A., D.I.C., F.G.S., F.N.I., Director, Mysore Geological Department; 'Srinibas', Visvesvarapuram, Bangalore City.

RAO, B. Sanjiva, M.A., Ph.D. (Lond.), D.Sc., H.E.H., The Nizam's Professor of Inorganic and Mineral Chemistry, Indian Institute of Science, Bangalore.

RAO, C. J. Dassa, Rao Sahib, Andhra University, Waltair.

RAO, G. S. Raghunath, B.Sc., M.B.B.S., D.Phil.(Oxon.), Assistant Professor of Pharmacology, University Medical College, Mysore.

RAO, G. V., M.Sc. (Andhra), Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

RAO, I. Ramakrishna, M.A., Ph.D., D.Sc., (Lond), Prof. Technical Research Laboratory, Andhra Scientific Co. Ltd, Masulipatam.

RAO, K. K. P. Narasinga, M.Sc., A.R.I.C., Nutrition Officer, Fao. of the United Nations, 301, Connecting Avenue, N. W. Washington 6, D. C. (U.S.A.).

RAO, K. Rangadhama, Professor of Physics, Andhra University, Guntur.

RAO, K. Subba, D.Sc., Lecturer in Chemistry, Central College, Bangalore.

RAO, K. V. KRISHNAMURTHY, Geologist, Modya Bharat, Indragunj, Gwalior.

RAO, L. Narayana, M.Sc., Ph.D. (London), F.R.M.S., Professor of Botany, Central College, Bangalore.

RAO, L. Rama, M.A., F.G.S., F.A.Sc., F.N.I., Professor and Head of the De artment of Geology, Central College, Bangalore.

RAO, M. N., M.B.B.S., M.P.H.Dr.Ph., Assistant Professor of Industrial & Physiological Hygiene, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

RAO, M. V. Radhakrishna, M.B.B.S., Ph.D., Assistant Director, Haffkine Institute Bombay 12.

RAO, Mannigay Umanath, M.Sc., A.I.C., Analytical Chemist, Government Chemist P.W.D., 'Shanti Nivas,' Sardarpura, Jodhpur, Rajputana.

RAO, Poona Appaji, B.Sc., Industrial Chemist, Essential Oils & Aromatic Chemicals, Station Road, Bhandup, Bombay (Subarban).

RAO, P. S., B.Sc. (Eng.), M.R.S.A. (Eng.), 8-15, Aryanagar, Kanpur.

RAO, S. R., M.Sc., D.Sc., Parasitologist, Civil Veterinary Dept., Bombay Veterinary College, Parel, Bombay.

Rao, S. Raghavender, L.M.S., (Hyd.), D.T.M., D.P.H., D.Sc. (Cal.), Epidemiologist, Public Health Department, 367, Vithalwadi, Hyderabad-Deccan.
Rao, S. Ramachandra, M.A., Ph.D., D.Sc. (Lond.), F.Inst.P., Professor of Physics, Central College, Bangalore.
Rao., T. V. Subba, M.Sc., Chemist, Tata Oil Mills Co., Ltd., Tatapuram, Cocin State.
Rao, V. L. S. Prakasa, M.A., Research Scholar, Geography Department, Calcutta University, Senate House, Calcutta.
Rao, Y. Ramchandra, Rao Bahadur, M.A., F.R.E.S., Deputy Director, Plant Protection Bureau, Department of Agriculture, Secretariat, New Delhi.
Rau, A. Subba, B.A., D.Sc., F.R.M.S., Professor of Zoology, Central College, Bangalore.
Ravalgaon Sugar Farm Ltd., Ravalgaon (Nasik District).
Ray, A. Barman, M.A., Rationing Officer, Civil Supplies, Govt. of West Bengal, 23, Sarkar Lane, Calcutta-7.
Ray, A. K., M.Sc. Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
Ray, Dipak, 52, Indian Mirror Street, Dharamtola P.O., Calcutta.
†**Ray**, Harendranath, M.Sc., (Cal.), Ph.D. (Lond.), Protozoologist, Indian Veterinary Research Institute, Muktesar-Kumaun, U. P.
Ray, J. C., M.D., Director, Indian Institute for Medical Research, P-27, Princep Street, Calcutta.
Ray, J. N., O.B.E., D.Sc., F.I.C., F.N.I., Director, Production of Drugs and Dressings, Office of the Director-General, Indian Medical Service, New Delhi.
Ray, Karunamay, B.Sc., (Cal.), B.Sc. (Hon.), (Lond.), A.M.Inst.C.E., A.M.Struct,E., Chartered Civil Engineer, Resident Engineer, Hindusthan Co-operative Insurance Society, Ltd., 6-A, Surendranath Banerjea Road, Calcutta.
Ray, N. C., M.Sc., Deputy Director, Agricultural Marketing Branch, Government of West Bengal, Writers Building, Calcutta.
Ray, Priyadaranjan, M.A., F.N.I., Palit Professor and Head of the Department of Chemistry, University College of Science and Technology, 92, Upper Circular Road, Calcutta.
Ray, R. C., D.Sc., F.I.C., F.I.I.Sc., Professor and Head of the Department of Chemistry Science College, P.O., Bankipore, Patna.
Ray, S. B., M.B., L.M., D.G.O., 15-B, Earle Street, Calcutta.
Ray, Satyendra Nath, M.B., F.R.C.S., D.T.M. & H., Medical Practitioner, 34, Allenby Road, P.O. Elgin Road, Calcutta.
Ray, S. C., B.Sc. (Cal.), B.Sc. Tech. (Manches.), Chief Electrical & Mechanical Engineer, The Ballarpur Collieries Co., P.O. Ballarpur, Dist. Chanda, C. P.
Ray, S. C., B.A., B.Sc. Agri. (Wales.), B.Sc. HONS. Ag. Econ. (Wales.), Deputy Director of Agriculture, West Bengal, 33, Baker Road, Alipore, Calcutta.
Ray Chaudhuri, S. P., Zoological Laboratory, University College of Science, 35, Ballygunge Circular, Road, Calcutta.
Raychaudhuri, S. P., M.Sc. (Cal.), Assoc. I.A.R.I., Assistant Virologist, Indian Agricultural Research Institute, New Delhi.
Ray Chaudhuri, S. P., D.Sc. (Lond.), Ph.D., Soil Survey Officer, Indian Agricultural Research Laboratory, New Delhi.
Razack, H. M. Abdul, Chirag Ali Lane, Hyderabad-Deccan.
Reddi, D. V., B.E.M., B.Sc. (Met.), A.I.M., A.R.I.C., Assistant Inspector of Metal & Steel, Ishapore (West Bengal).
Reddy, B. Ranga, Joint Revenue Secretary, Nizam's Government, Bholakpur, Secunderabad (Deccan).

Reddy, D. V. Subba, M.B.B.S., Department of Physiology, Medical College, Madras.
Rizvi, S. M. Tahir, B.A. (Hons.), (Lond.), Ph.D. (Lond.), M.A., LlB., F.R.G.S., F.R.M.S., Bar-at-Law, Chairman, Department of Geography, Muslim University, Aligarh.
Rode, K. P., Ph.D., Chief Geologist, Rohtas Industries, Dalminagar.
Rohatgi, Binay Krishna, Chemist and Industrialist, 45, Armenian Street, Calcutta.
Rohatgi, (Miss) Krishna Kamini, M.Sc., 45, Armenian Street, Calcutta.
Rohtas Industries Ltd., Dalmianagar, Rly. Station, Dehri-on-Sone, E. I. Ry.
Roonwal, M. L., M.Sc., Ph.D. (Cantab), F.N.I., Zoological Survey of India, Kaisar Castle, Benares Cantt.
Roi Chaudhuri, Bhuban Mohan, M.Sc., 96, Masjid Bari Street, Calcutta 6.
Roy, Anukul Chandra, M.Sc., Surath Cottage, Burdwan.
Roy, B. C., M.Sc. (Lond.), D.I.C., Dr. Ing. (Freiberg.), Superintending Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
Roy, Sri, Benoy Kumar, Tele-Communication Engineer, C/o. G.E.C. (India) Ltd., Magnet House, Central Avenue, Calcutta.
Roy, David, M.B.E., F.R.A.I., Dewan, Mylliem-Cherra State, Shillong, Assam.
Roy, H. L., A.B. (Harvard), Dr. Ing. (Berlin), M.I.Ch.E., Professor-in-Charge of the Chemical Engineering Department, College of Engineering and Technology, Bengal, P.O., Jadavpur College, Via Calcutta.
Roy, K. K., Radio Communication Engineer, C/o. G. E. C. (India) Ltd., Magnet House, Central Avenue, Calcutta.
Roy, P. C., P.O. Salarpore, Burdwan.
Roy, Pankaj, Central Glass & Ceramic Research Institute, Jadavpur, 24-Parganas.
Roy, Ramparikshen, Department of Botany, Science College, Patna.
Roy, S., D.Sc., Department of Applied Chemistry, University College of Science and Technology, 92, Upper Circular Road, Calcutta.
Roy, S., Superintendent, Coke Ovens and Bye products and Sulphuric Acid plants, The Tata Iron & Steel Co., Ltd., Jamshedpur.
Roy, Samarendra Nath, .MSc., F.N.I., Lecturer, Department of Statistics, Calcutta University, Asutosh Building, Calcutta.
Roy, Santosh K., Department of Geology, Presidency College, Calcutta.
Roy, Satyendra Prasad, Tea Planter, Post Box 59, Jalpaiguri.
Roy, S. C., Directorm Indian Institute of Sugar Techcnology, Nawabgunj Kanpur.
Roy, S. N., Manager, Bharatiya Engineer Works, P.O. Sahibganj, Santhet Parganas.
Roy, Surendra Kumar, M.E.E., (Harvard), M.A.I.E.E., College of Engineering and Technology, Bengal, P.O., Jadavpur College, 24-Parganas.
Roy Choudhuri, R. K., B.Sc. (Eng.), 39C, Jainuddin Mistry Lane, Alipore.
Roy Choudhury, B., Sectional Officer, C.P.W.D., 14, Madan Street, Calcutta.
Roy Chowdhury, M. K., M.Sc., Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
Roy Choudhury, P. K., Senior Chemist, Processing Dept., Kassipur Co. Ltd., P.O. Alambazar, Dept., 24-Parganas.
Roy, Chowdhury, Tarak Chandra, Lecturer in Anthropology, University College of Science; 32/B, Allenby Road, P.O. Elgin Road, Calcutta.
Roy Choudhury, Anil Baran, 16, Lansdowne, Terrace, Calcutta 29.
Roychowdhury, K., Manufacturer of Analytical Balances, Benares Cantt.
Roy Choudhury, S. N., B.Sc., A.C.G.I. (Lond.), Executive Engineer, C.P.W.D.?, Electrical æ Transport Division, Chowringhee Sq., Calcutta.
***Rubugunday**, R. K., M.A., (Cantab), Wrangler Prize Winner, Professor of Mathematics, Saugor University, 12 Saugor Cantt., King's Road, C. P.

RUDRA, J. N., Prof. of Zoology, Vidyasagar College, 39, Sankar Ghosh Lane, Calcutta.

RUDRA, M. N., Prof. of Medical Chemistry, Darbhanga Medical College, P.O. Laheria Sarai, Bihar.

S

SABNIS, T. S., B.A. (Hons.), D.Sc., F.A.Sc., I.A.S., Principal, Agricultural College and Economic Botanist to the Government of U.P. Agricultural Gardens, Nawabganj, Kanpur.

SADASIVAN, T. S., M.Sc., Ph.D., Director, The University Botany Laboratory, Triplicane P.O., Madras.

SADGOPAL, M.Sc., (Tech.), D.Sc., F.C.S., F.R.H.S., F.R,I,C,, Department of Industrial Chemistry, College of Technology, Benares University, Benares.

SADHU, D. P., L.M.F., M.Sc., Ph.D., I.R.F.A., Research Assistant, C|o. Central Drugs Laboratory, Govt. of India, 110, Chittaranjan Avenue, Calcutta.

SAHA, A. K., M.Sc., Geological Survey of India, 27, Chowringhee, Calcutta.

SAHA, Abinash Chandra, M.Sc., 4C, Sitaram Ghosh Street, Calcutta 9.

SAHA, Ajit Kumar, M.Sc., Geological Assistant, Geological Survey of India, 4C, Sitaram Ghosh Street, Calcutta 9.

SAHA, Kamakhya Charan, M.Sc., C/o. National IndustrialTrading Co., 84-A, Netaji *Subhas* Road, Calcutta.

SAHA, N. K., Department of Physics, University of Delhi, Delhi.

SAHA, Srish Kumar, M.Sc., Research Chemist, Bengal Chemical & Pharmaceutical Works Ltd., 164 Manicktala Main Road, Calcutta.

SAHASRABUHE, R. H., Dept. of Chemistry, College of Science, Benares Hindu University, Benares.

SAHNEY, Shri J. C., Executive Engineer, Lucknow Provl. Division, Lucknow.

*SAHNI, B., M.A., Sc.D. (Cantab), D.Sc. (London), F.R.S., Professor of Botany, Lucknow University, Lucknow.

SAHNI, M. B., M.A., Ph.D., 18, Clyde Road, Lucknow.

SAKSENA, Ram Kumar, D.Sc., Reader in Botany, Allahabad University, Allahabad.

SAKSENA, Shiv Dayal, M.Sc., Visharad, Professor of Botany, Darbar College, Rewa C.I.

SALETORE, S. A., B.Sc., A.I.I.Sc., Ph.D., (L'pool), A.I.C. (Lond,), Professor of Chemical Technology and Director-in-Charge, Laxminarayan Institute of Technology, Nagpur University, Nagpur.

SANE, J. B., M.Sc., A.R.I.C., Textile Chemist, Khatau Mills, Byculla, Bombay 8.

SANKALIA, H. D., M.A.LL.B., Ph.D., Professor and Head of the Department of History, Deccan College Post Graduate & Research Institute, Poona.

SANKARAN, C. R., Reader-in-Charge of Phonetics Laboratory, Deccan College Research Institute, 10, Connaught Road, Poona.

SANYAL, B. B., M.R.S.I., M.R.San.I. (Lond.), C/o. Janki Deby, 36, Kalupara Lane, P.O. Bandhaghat, Howrah.

SARABHAI, (Mrs.) Mrinalini, C/o. Vikram A. Sarabhai, Post Box 28, Ahmedabad.

SARABHAI, Vikram A., M.A., (Cantab), Post Box 28, Ahmedabad.

SARASWATI Sugar Mills, Abdullapur, Ambala District.

SARBADHIKARI, P. C., D.Sc. (Lond.), Ph.D., D.I.C., F.L.S., Ghose Professor of Botany, Calcutta University, 35, Ballygunge Circular Road, Calcutta.

SARKAR, A. K., 2B, Cornfield Road, Calcutta.

SARKAR, Anup Sundar, A.M.I., Mech.E., Worthington Seripson, 10, Clive Street, Calcutta.

SARKAR, B. K., M. I. Metal, Chartered Engineer, Director, Agricultural Machinery Manufacturing Corporation Ltd., and National Aluminium Products, 14-2, Bhabanath Sen Street, Calcutta.

SARKAR, Benoy Kumar, Dr. h.c., Vidyavaibha, 45, Girish Bose Road, Calcutta 14.

SARKAR, Bijali Behari, D.Sc., (Edin.), F.R.S.E., Head of the Post Graduate Dept. of Physiology, Calcutta University, University College of Science, 92, Upper Circular Road, Calcutta.

SARKAR, H., 177, Upper Circular Road, P.O., Shambazar, Calcutta.

SARKAR, N. G., Director, Scientific Indian Glass Co., Ltd., 98, Christophar Road, Calcutta.

SARKAR, P. B., Dr.-es-Sc., A.I.C., F.N.I., University Lecturer in Chemistry, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

SARKAR, S. S., Research Fellow in Anthropology, Bose Institute, 93, Upper Circular Road, Calcutta.

SARKAR, Sudhangsu, B.Sc., Covenanted Assistant, M|S. Bird & Co., Chartered Bank Buildings, 17, Lansdowne Road, Calcutta 29.

SARKAR, (Mrs.) Suniti, 3?-3, Lansdowne Road, Calcutta.

SARKAR, (Mrs.) Uma, Director, Agricultural Mashinary Manufacturing Corp. Ltd., 38-1, Bose Para Lane, P.O. Bagbazar, Calcutta.

SARMA, (Mrs.) Kamalmani, M.Sc., Geophysical Assistant, Geological Survey of India, 27, Chowringhee, Calcutta.

SARMA, P. S., M.Sc., Ph.D., Asst. Research Officer, Nutrition Research Laboratory, Coonoor.

SASTRI, N. S. R, Director of Statistics, Department of Research and Statistics, Reserve Bank of India, Bombay.

SASTRI, T. P. Bhaskera, M.A., F.R A.S., Director, Nizamiah Observatory, Begumpet, Hyderabad-Deccan.

SASTRY, N. S. N., M.A., Department of Psychology, Maharaja's College, Mysore.

SAVUR, S. R., M.A., Ph.D., (Lond.), Director, Tambyacha Bungla, Colaba, Bombay.

SAWHNEY, Kalidas, Rai Bahadur, M.Sc., Director of Agriculture, Hyderabad-Deccan.

SAXENA, M. C., Lecturer in Physics, Lucknow University, Lucknow.

SAYEED-UD-DIN, M., M.A. (Edin), B.Sc., F.R.M.S., Professor of Botany, Osmania University, P.O. Lallaguda, Hyderabad-Deccan.

SCHROFF, Mahadeva, L., A.B. (Hons.), (Cornell), M.S. (Mass), 8, Royal Exchange Place, Calcutta.

SCHWARZ, Anton, C/o. The Indian Standard Metal Co., Ltd., Chinchpokli Cross Lane, Bombay 27.

SCIENTIFIC Apparatus and Chemical Works Ltd., Agra, U.P.

SEAL, Srish Chandra, M.B., D.P.H., F.A. P.H.A., Asst. Professor of Epidemiology, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

SEGAL, K. N., M.B.B.S., D.P.H. (Cantab), D.T.M. & H. (Lond.), M,R,S,M,, Lecturer, Provincial Hygiene Institute, Lucknow.

SEN, A., M.A., B.L., Professor, City College, and Head of the Department of Studies in Political Science, Nagpur University, Nagpur.

SEN, A. B., M.Sc., Ph.D., Lecturer in Chemistry, Lucknow University, Lucknow.

SEN, A. C., Entomologist to Govt., Bihar, P.O. Sabour, Dist. Bhagalpore.

SEN, A. C., Entomologist to Govt. Bihar, P.O. Sabour, Dist. Bhagalpore.

SEN, A. K., Chief Inspector Explotions, New Delhi.

SEN, A. K. Electrical Engineer, C|o. G.E.C. (India) Ltd., Magnet House, Central Avenue, Calcutta.

SEN, Alok, M.Sc., Professor of Botany, Vidyasagar College, 39, Sankar Ghose Lane, Calcutta.

SEN, Anil Kumar, M.B., 45, Ballygunge Place, Calcutta.

SEN, Asoke Kumar, M.Sc., Managing Director, East India Pharmaceutical Works Ltd., 71, Russa Road, Calcutta.

SEN, B., Superintendent of Prospecting, Tata Iron & Steel Co., Ltd., Jamshedpur.

SEN, B. M., M.A., I.E.S., F.N.I., 16, Palm Avenue, Ballygunge, Calcutta.

SEN, B. N., B.Sc., Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

SEN, Baridbaran, M.Sc., M.B.B.S., Lecturer in Physiology, Department of Physiology, University College of Science, 92, Upper Circular Road, Calcutta.

SEN, Basiswar, B.Sc., Director, Vivekananda Laboratory, Almora, U.P.

SEN, D. M., M.A., Ph.D. (Lond.), Secretary, Department of Education, Government of West Bengal, Writers' Building, Calcutta.

SEN, D. M., B.Sc. Min. (Banaras), Assistant Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

SEN, Dharanidhar, M.Sc., Professor of Geography, Vidyasagar College, Calcutta.

SEN, G. C., Rai Bahadur, M.A., Secretary, Indian Central Jute Committee, 4, Hastings Street, Calcutta.

SEN, H., Geologist, Prospecting Dept., Tata Iron & Steel Co., Ltd., Jamshedpur.

SEN, Harakali, Chief Coal Inspector, Jamaduba Jealgort, P.O., Dt. Manbhum.

SEN, Indra, M.A., Ph.D., Sri Aurobinda Assam, Pondicherry.

SEN, J., M.A., Lecturer in Botany, University College of Science, 35, Ballygunge Circular Road, Calcutta.

SEN, J. K., Capt., M.B., D.T.M., 18, Kasinath Dull Road, Baranagore, 24-Parganas.

SEN, J. M., Rai Bahadur, M.Ed. (Leeds.), B.Sc. (Cal.), T.D. (Lond.), Dip-Ed. (Oxford), F.R.G.S., F.N.I., Principal, Krishnagar College, 28, New Road Alipore, Calcutta.

SEN, J. R., Engineer, B. P. Mills, Raniganj, E. I. Ry.

SEN, K. B., M.Sc., A.I.C., Chemist-in-Charge, Messrs. Bird & Co.'s Research Department, Chartered Bank Buildings, Clive Street, Calcutta.

SEN, N. N., M.Sc., A.R.S.M., Principal and Professor of Chemistry, Bengal Engineering College, P.O. Botanic Garden, Howrah.

SEN, Nalinbihari, M.Met., B.Sc., F.R.I.C., F.I.M., Technical Assistant to Director, Tata Industries Ltd., 34, Circuit House Area, Jamshedpur.

SEN, Nikhil Ranjan, D.Sc., (Cal.), Ph.D. (Berlin), F.N.I., Ghose Professor of Applied Mathematics, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

SEN, Nirad Kumar, Lecturer in Botany, Presidency College, Calcutta.

SEN, Nirmal Kumar, M.A., D.Sc., Professor of Chemistry, Presidency College, Calcutta.

SEN, Parimal Bikas, Lecturer in Physiology, University College of Science, 92, Upper Circular Road, Calcutta.

SEN, P. K., M.Sc. (Cal.), Ph.D. (Lond.), D.I.C., Physiological Botanist, Agricultural Research Institute, P.O. Sabour, Bihar.

SEN, P. K., Physician-in-Charge, Chest Department, Medical College Hospital, Calcutta.

SEN, Purnendu, M.Sc., Ph.D., D.I.C., Entomologist, Directorate of Health Services, Govt. of West Bengal, School of Tropical Medicine, Calcutta.

SEN, Ranjit Kumar, M.Sc., Research Assistant, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.

SEN, S. K., M.Sc., M.B., (Cal.), L.M., Professor of Physiology, Carmichael Medical College, 43-3, Hazra Road, Calcutta.

SEN, S. K., M.Sc., Hotel Savoy, 27, Sashi Bhusan Dey Street, Calcutta 12.

SEN, Satya Prasanna, M.Sc., Manager and Secretary, Bengal Chemical and Pharmaceutical Works, Ltd., 164, Manicktollah Main Road, Calcutta.

SEN, Saurindranath, Dept. of Geology, University of Calcutta, Geological Laboratory, Presidency College, Calcutta.

SEN, Suprakash, Professor of Protozoology, School of Tropical Medicine, Calcutta.

SEN, Suresh Chandra, Superintendent, Cinchona Cultivation in Bengal, Mungpoo, Riyang, D. H. Ry.

SEN, T. K., Sectional Officer, C.P.W.D., P47, Raja Basanta Roy Road, Rashbehari Avenue P.O., Calcutta.

SEN, Triguna, Dr. Ing. (Munich), A.M.M.E., A.M.I.E. (Lond.), Principal, College of Engineering and Technology, Bengal, P.O. Jadavpur College, 24-Parganas.

SEN GUPTA, H. L., Managing Director, Union Bank of Bengal Ltd., Clive Buildings, 8, Clive Street, Calcutta.

SEN-GUPTA, J. C., M.Sc. (Cal.), Dr.Phil.Nat (Heidelburg), Professor of Botany and Head of the Department, Presidency College, Calcutta.

SEN-GUPTA, M., B.Sc., (Cal.), B.Sc., (Eng,), C.P.E. (Glas.), M.I.E.E., (Lond,), M,I,E,, A.M.I.M.E., F.I.P.S., Principal, Engineering College, Benares Hindu University, Benares.

SEN-GUPTA, N. C., D.Sc., A.R.I.C., M.Inst.Pet., Chemist-in-Charge, B. O. C. Development Research and Honorary Lecturer in Chemistry, Calcutta University, 11, Gurusaday Road, Ballygunge, Calcutta.

SEN-GUPTA, Pratul Nath, M.Sc., A.R.I.C., Department of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

SEN, GUPTA, N. K., Director of Telegraph Engineering, Posts & Telegraphs Dept., Alipore, Calcutta.

SEN-GUPTA, P. C., M.B., Officer-in-Charge, Kala-azar Research Department, School of Tropical Medicine, Calcutta.

SEN, GUPTA, Sadashiv, 90, Basanta Roy Road, Kalighat P.O., Ballygunge, Calcutta.

SEN-GUPTA, S. C., Assistant Post Master-General, Bengal, 1, Council House Street, Calcutta.

SEN-GUPTA, Sudhir Ranjan, B.Sc., Ph.D., A.M.I.E., Assistant Educational Adviser, Education Department, Government of India, New Delhi.

SESHACHALAM, T., (Sastravaidyapravina), L.M.S., M.R.C.S. (Eng.), L.R.C.P. (Lond.), Durbar Surgeon and Medical Officer, Victoria Hospital, Bangalore.

SESHACHAR, B. R., D.Sc., Professor of Zoology, Central College, Bangalore.

SESHADRI, T. R., M.A., Ph.D., F.I.C., Vikrama Deo Professor of Chemistry, Andhra University, Waltair.

SESHADRINATHRN, N., Asst. Director, King Institute, Guindy, Madras.

SESHAIYA, R. V., M.A., Professor of Zoology, Annamalai University, Annamalainagar, S. India.

SETH, B. R., M.A., D.Sc. (Lond.), Professor of Mathematics, Hindu College, Delhi.

SETHNA, Suresh, Laxmi Niwas, Juhu Road, Santa Curz, Bombay 23.

SETNA, S. B., Ph.D., F.R.M.S., Fisheries Officer, Department of Industries, Old Custom House, Bombay.

SHADDE, N. G., D.Sc., Principal, Robertson College, Jubbulpore.

SHAH, C. C., M.Sc., Ph.D., F.R.I.C., Professor of Chemistry and Head of Animal Nutrition Section, Institute of Agriculture, Anand.

SHAH, Kantilal A., M.B.B.S., Medical Officer-in-Charge, Ranchhodlal Dispensary, Panehkuwa, Ahmedabad.

SHAH, M. L., M.Sc., Ph.D., Professor of Chemistry, M. N. College, Visnagar.
SHAH, M. S., M.Sc. (Bom.), Ph.D. (Lond.), D.I.C., Professor of Chemistry, Gujarat College, Ahmedabad.
SHAH, N. M., M.Sc., Ph.D., Department of Chemistry, Gujarat College, Ahmedabad.
SHAH, P. G., M.A., B.Sc., I,A,A,S., Lalit Kunj, 11th Road, Khar, Bombay 21.
SHAH, R. C., M.Sc., Ph.D., (Lond.), A.I.I.Sc., Professor of Organic Chemistry, Royal Institute of Science, Fort, Bombay 1.
SHAH, S. M., M.A., Ph.D. (Lond.), Lecturer, Muslim University, Aligarh.
SHAH, S. V., B.Sc., Ph.D., Professor of Chemistry, Rajaram College, Kolhapur.
SHAHA, A. K., Mining Corporation Ltd., 21, Old Court House Street, Calcutta.
SHARIF, M., D.Sc. (Panj.), Ph.D. (Cantab), B.M.S. (I.), Entomologist and Plague Research Officer, Haffkine Institute, Parel, Bombay.
SHARMA, N. L., Officiating Professor of Geology, Indian School of Mines, Dhanbad.
SHARMA, P. N., D.Sc., Department of Physics, Lucknow University, Lucknow.
SHARMA, Yajna Datta, M.A., D.Phil., (Oxon.), Assistant Superintendent, Department of Archaeology, Eastern Circle, 32, Chittaranjan Avenue, Calcutta 12.
SHASTRI, N. A., King Edward College, Amraoti, Berar.
SHAW, Joseph S., Asst. Director of Fisheries, P.O. Kedinra (Kathiwar).
SHEVADE, Shivaram Vinayak, B.Sc., Professor of Biology, Baroda College, Baroda.
SHORT, G. V., Lt. Col., I.C.I. (India) Ltd., 18, Strand Road, Calcutta.
SHREE Hanuman Sugar Mills Ltd., 178, Harrison Road, Calcutta.
SHUKLA, P. D., M.A., Ph.D., Education Officer, Department of Education, Govt. of India, Simla.
SHUKLA, Soorya Narayan, M.Sc., (Luck.), Ph.D., (Lond.), A.I.C., Lecturer in Chemistry, Lucknow University, Lucknow.
SIDDIQI, Jamil Ahmad, Research Scholar, Department of Mathematics, Allahabad University, Allahabad.
SIDDIQI, M. R., Ph.D., D.Sc., F.N.I., Director, Research Institute, Osmania University, Wooden Bridge, Saifabad, Hyderabad-Deccan.
SIDDIQUI, S., D.Sc., Director, Chemical Laboratories, Council of Scientific and Industrial Research, Old Viceregal Lodge, Delhi.
SIDHU, G. S., Chemistry Department, Lucknow University, Lucknow.
SINGH, Bawa Kartar, M.A. (Cantab), Sc.D., F.I.C., F.N.I., Hony. Research Professor of Chemistry, Benares Hindu University, Benares.
SINGH, Shri Chhotey, B.Sc. (Agr.), Entomological Assistant, C|o. The Entomologist to Govt. Kanpur. U. P.
SINGH, D. R., M.A., L.T., Capt., K.G.R.I.M., College, Jullundur Cantt.
SINGH, Dalip, M.Sc., Ph.D., (Cantab), Officer on Special Duty, Department of Agriculture, East Punjab, Dagshai (Simla Hills).
SINGH, Damri, Dept. of Chemistry, College of Science, Benares Hindu University, Benares.
SINGH, Rudra Pal, M.Sc., Lecturer, Physics Department, Allahabad University, Allahabad.
SINGH, T. C. N., M.Sc., D.Sc., Chief Agriculture Superintendent, Gopalpur Agricultural Farms Ltd., North Bengal Sugar Mills, Gopalpur, Rajshahi.
SINGH, Udai Bhan, M.Sc., D.Phil., Plant Pathologists Govt. of U.P. Kanpu.
SINGH, Udita Narayan, 7A, Tagore Town, Allahabad.
SINGHI, Narendra Singh, M.Sc., B.L., M.L.A., 48, Gariahata Road, Singhi Park, Ballygunge, Calcutta.

SINHA, B. N., Asst. Geologist, Geological Survey of India, 27, Chowringhee, Calcutta 13.
SINHA, G. P., Principal, Technical College, Dayalbagh, Agra.
SINHA, (Miss) Leela, M.A., C/o. Jamuna Prasad, Esqr., Kadamkuan (New area), Patna.
SINHA, N. C., Engineer, Kassipur Co., Ltd., P.O. Alambazar, 24-Parganas.
SINHA, Ramanath, Capt., M.B., 'Sunny Bank,' Chinsurah, Bengal.
SINHA, Suhrid Chandra, M.Sc., Department of Psychology, University College of Science, 92, Upper Circular Road, Calcutta.
SIRCAR, S. K., M.Sc., Ph.D., A.R.S.M., D.I.C., Chemical Engineer, P.O, Kusunda, Manbhum.
SIRCAR, S. M., M.Sc., (Cal.), Ph.D., (Lond.), D.I.C., Lecturer in Botany, University College of Science, 35, Ballygunge Circular Road, Calcutta.
SIRCAR, S. N., Technical Assistant, Works Manager's Office, Tata Iron & Steel Co., Ltd., Jamshedpur.
SIRKAR, S. C., D.Sc., F.N.I., Professor of Physics, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.
Upper Circular Road, Calcutta.
SITHOLEY, R. V., Department of Botany, Lucknow University, Lucknow.
SOHNIE, (Mrs.) Kamala, M.Sc., Ph.D. (Centeb), Anand Ashram, Matunga, Bombay 19.
SOKHEY, Sir S. S., Kt., M.A., D.Sc., M.D., D.T.M. & H., F.N.I., Lt.-Col., I.M.S Director, Haffkine Institute, Parel, Bombay.
SOMAN, Dattatray Waman, M.B., D.P.H., D.T.M. & H., B.M.S.I. (Lond.), Research Officer, Haffkine Institute, Parel, Bombay.
SONDHI, Ved Pall, M.B.E., M.Sc., F.G.S., Geological Survey of India, 27, Chowringhee, Calcutta.
SOPARKAR, M. B., M.D., B.Hy., F.N.I., Research Officer, Cholera Enquiry, Indian Research Fund Association, 117, Khar, Bombay, 21.
SREENIVASAIAH B. N., M.Sc., F.A.Sc., Meteorologist, Meteorogical Office, P.O. St. Thomas Mount, Madras.
SRIKANTIA, C., B.A., D.Sc., Retd. University Professor of Chemistry, 1194, Chamarajapuram, Mysore.
SRINIVASAN, R., Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta. 12.
SRIVASTAVA, B. N., D.Sc., Lecturer in Physics, Allahabad University, Allahabad.
SRIVASTAVA, Girja Dayal, Lecturer in Botany, University of Lucknow, Lucknow.
SRIVASTAVA, H. D., D.Sc., Research Officer, Indian Veterinary Research Institute, Izatnagar, Bereilly.
SRIVASTAVA, H. N., B.Sc., M.I.E.E., Additional Chief Engineer, Posts and Telegraphs, Eastern Court, New Delhi.
SRIVASTAVA, L. N., M.Sc., Lecturer in Chemistry, Lucknow University, Lucknow.
SRIVASTAVA, P. L., Reader, in Mathematics, University of Allahabad, Allahabad.
SUBRAHMANYAM, K., Asst. Professor of Biochemistry, Orissa Medical College, Cuttack.
SUBRAMANIAN, T. S., Superintendent, Development Laboratory, Post Box 127, Cawnpore.
†SUBRAHMANYAN, V., D.Sc., F.I.C., F.N.I., Professor of Biochemistry, Indian Institute of Science, Malleswaram, Bangalore.
SUD, Baldev Chand, Chief Development Research Chemist, M/S. Shalimar Tar Products Ltd., Lodna, Jharia.

SUKHATME, P. V., Ph.D., D.Sc. (Lond.), F.N.I., Statistical Adviser, Imperial Council of Agricultural Research, Tarachand Buildings, Connaught Circus, New Delhi.

SUNDARACHAR, C. K., M.A., Assistant Professor of Physics, Central College, Bangalore.

SUNDARARAJAN, A. R., M.Sc., Chemist, Nutrition Research Laboratory, Coonoor.

SUR, M. M., Sur Enamel & Stamping Works Ltd., 9, Middle Road, Entally, Calcutta.

SUR, Sri Sudhansu Kumar, M.Sc., 14P, Middle Road, P.O. Entally, Calcutta-14.

SURMA Valley Technical School, Principal, Sylhet.

*SWAMI, Purushottama, Dasa, M.Sc., F.I.C.S., F.G.M.S., Visharad, Department of Chemistry, Dungar College, Bikaner.

SWAMI, T. V., Development Minister, Government of Dungarpur, 'Retreat,' Hyderabad-Deccan.

SWAMINATHAN, B., Professor of Physics, The Maharana Bhopal College, Udaipur.

SWAROOP, S., C|o. Post Master, Bareilly, (U.P.).

SWARUP, D., Ph.D., (Shefield), A.I.E., M.I.M., M.I. & S.I., M.M,G,I,, Principal, College of Mining and Metallurgy, Benares Hindu University, Benares.

T

TAGORE, Pranab Nath, Businessman & Landlord, Tagore Villa, Dehra-Dun.

TALWALKAR, Trymbak Waman, M.S. (Illinois), Geramist, Tata Iron & Steel Co., Ltd., 8, Bagmati Road, Jamshedpur.

TAMBE, G. C., B.Ag., State Manager, Daly College, Indore C.I.

TANDON, R. N., Lecturer in Botany, University of Allahabad, Allahabad.

TAPADAR, D. C., M.Sc., Chief Chemist, Indian Paper Pulp Co., P.O. Hazinagar, Naihati.

TARE, N. B., M.Sc. (Bom.), Lecturer in Botany, Willingdon College, Sangli S. M. C., Ichalkaranji.

TATA OIL MILLS COMPANY LTD., Tatapuram, Cochin State.

TAWDE, N. R., B.A., (Hons.), M.Sc., (Bom.), Ph.D., (Lond.), F.Inst.P,, F,A,Sc,, F.N.I., Professor of Physics, Spectorscopic Laboratories, Royal Institute of Science, Mayo Road, Bombay.

TELANG, M. S., M.Sc., University Lecturer in Applied, Physical and Inorganic Chemistry, Laxminarayan Institute of Technology, Nagpur.

THACKER, D. D., Diwan Bahadur, M.I.M.E., F.R.S.A., (Lond.), Honorary Magistrate (First Class), Colliery Owner, Pure Jharia Colliery, Jharia (Manbhum).

THAKAR, V. M., M.Sc., Department of Organic Chemistry, Royal Institute of Science, Bombay.

THAKORE, (Miss) Kusum V., M.A. (U.S.A.), Pestonji Villa, Fatehganj, P.O. Baroda Presidency.

THAKUR, B. B., B.Ag., S.A.S., Assistant Cotton Breeder in Sind, P.O. Agricultural College, Sakrand (Sind).

THAKUR, Ram Sinha, D.Sc. (Lond.), Ph.D., M.Sc. (Nagpur), Scientific Adviser, General Staff Branch (G.S.W.), Army Head Quarter, New Delhi.

THAKUR, S. A., C|o. Lalchand Hirachand, Construction House, Wittet Road, Ballard Estate, Bombay.

THAPAR, G. S., M.Sc., Ph.D., Indian Council of Agricultural Research, Lucknow University, Lucknow.

THE Indian Wood Products Co. Ltd., Chemical Manufacturer, 8, Clive Street, Calcutta.

THYAGARAJAN, S., Fishery Department, Government Fishery, 8, Ormes Road, P.O. Kilpauk, Madras.

TIWARY, N. K., M.Sc., Botany Department, Benares Hindu University, Benares.

TRAVANCORE Rayons Ltd., The United Indian Life Building, Esplanade, Madras.

TRIBEDI, B. P., M.B. (Cal.), D.B. (Lond.), F.N.I., Professor of Pathology, Medical College, and Bacteriologist to the Government of Bengal, Calcutta.

TRIVEDI, Harbhai, President, Home School, Bhavnagar.

U

UKIL, A. C., M.B. (Cal.), M.S.P.E. (Paris), F.S.M.F.B., F.N.I., Principal, Medical College Hospital, Calcutta.

UNNY, M. Mukundan, B.Sc., (Hons.), Research Assistant, Government Fisheries, Pamban P.O., Ramnad Dist., S. India.

UPADHYAY, M. P., Chemical Assistant, Fisheries Research Laboratory, Badshahbagh, Lucknow.

V

*VAD, B. E., M.D., Consulting Physician, Peerbhoy Mansions, Sandhurst Road, Girgaon, Bombay 4.

VAIDYA, B. K., M.Sc., Ph.D., Singhanee Lecturer in Optics, Department of Chemical Technology, Bombay University, Matunga Road, Bombay 19.

VARMA, P. S., M.Sc., A.I.I.Sc., Professor of Organic Chemistry, Hindu University, Benares.

VASUDEVA, R. S., Indian Agricultural Research Institute, New Delhi.

VELKAR, M. B., L.M. & S., M.L.C., 372, Thakurdwar, Bombay 2.

VENKATACHALAM, K., Orissa Medical College, Cuttack.

VEERARAGHAVAN, N., Director, Pastur Institute, Coonoor (S. India).

VENKATARAMAN, K., D.Sc., F.I.C., A.M.I.Chem.E., Mody Professor and Director of the Department of Chemical Technology, Bombay University, Matunga Road, Bombay, 19.

VENKATESACHAR, B., Rao Bahadur, M.A., Professor of Physics, Central College, Bangalore.

VENKATRAMAN, Sir T. S., Kt., C.I.E., D.Sc., 56, Thyagaraja Road, Thyagarayanagar, Madras.

Thyagarayanagar, Madras.

VENKATARAMAN, T. V., M.Sc., F.R.E.S., Asst. Sugarcane Entomologist, Division of Entomology, Indian Agricultural Rech. Institute, New Delhi.

VENKATARAYUDU, T., M.A., Ph.D., F.A.Sc., Reader in Mathematical Physics, Andhra University, Waltair.

VENKATESWARAN, C. S., Prof. of Physics, University College, Trivendram.

VENUGOPAL, Sri K., M.A., Asst. Professor of Geology, Presidency College, Triplicane, Madras.

VESUGAR, J., 11, Safderjang Road, New Delhi.

VIJAYARAGHAVAN, P. K., M.Sc., Asst. Research Officer (Chemistry), Nutrition Research Laboratories, I.R.F.A., Coonoor, Nilgiris (S. I. Ry.).

VIJAYARAGHAVACHARYA, Sir T., K.B.E., F.N.I., Riverside, Adyar, Madras.

VIJAYARAGHAVAN, T., Staff Quarters, Andhra University, Waltair.

VISVA Bharati, Santiniketan, Bengal.

VISWANATH, B., Rao Bahadur, C.I.E., D.Sc., F.I.C., F.N.I., 15, Colvin Road, Civil Lines, Allahabad.

VISWANATHAN, G. R., Veterinary Investigation Officer, Vepery Post, Madras.

VISWANATHAN, K. S., Dept. of Chemistry, College of Science, Benares Hindu University, Benares.

VISWANATHAN, P. S., Rao Sahib, Agricultural Engineer to Government of U. P., Agri-Cultural Gardens, Nawabganj, Cawnpore.

VOHRA, Pran Nath, M.Sc., Chemical Laboratories, Council of Scientific Industrial Research, University Buildings, Delhi.

W

WADIA, D. N., M.A., B.Sc., F.G.S.., F.R.G.S., F.R.A,S,B,, F,N,I,, Director, Indian Bureau of Mines, Ministry of Works, Mines and Power, New Delhi.

WADIA, (Mrs.) Meher D. N., B.A., B.T. (Bom.), C/o. Mr. D. N. Wadia, as above.

WALAWALKAR, D. G., B.Ag., M.S., Department of Sugar Chemistry, Indian Institute of Sugar Technology, Nawabganj, Cawnpore.

WALCHANDNAGAR Industries Ltd., Walchandnagar, Poona.

†WEST, W. D., M.A., Sc.D., (Cantab), F.N.I., Director, Geological Survey of India, 27, Chowringhee, Calcutta.

Y

YADAVA, B. P, Ph.D., Lecturer in Chemistry, Lucknow University, Lucknow.

YEDDANAPALLI, Rev. Loardu M., S.J., Ph.D., (Princeton), D.Sc., (Louvain), M.A., Head of the Department of Chemistry, Loyala College, Cathedral, P.O., Madras 6.

YEOLEKAR, T. G., M.A., B.Sc., Biology Department, Nowrosjee Wadia College, Poona 1.

Z

ZAHEER, S. Hussain, B.A. (Oxon.), Ph.D., M.L.A., Reader in Chemistry, Lucknow University, Lucknow.

ZOOLOGICAL Survey of India, The Director, Kaiser Castle, Benares Cantonment.

Proceedings of the Thirty-fifth Indian Science Congress

PART II : PRESIDENTIAL ADDRESSES

CONTENTS

ACKNOWLEDGMENT

The cost of printing the Proceedings of the thirty-fifth session of the Indian Science Congress Association has been in part defrayed by a generous grant from the Rockefeller Foundation for the publication of results of scientific work made to us through the kindness of National Institute of Sciences of India.

THIRTY-FIFTH
INDIAN SCIENCE CONGRESS
PATNA, 1948

Congress President: Colonel Sir Ram Nath Chopra

PRESIDENTIAL ADDRESS

(*Delivered on 5th January, 1948*)

RATIONALISATION OF MEDICINE IN INDIA

INTRODUCTION

The highest honour which a scientist in this country can aspire to, is to be elected the President of the Indian Science Congress, and I wish to express my deep sense of gratitude to you for this distinction. On looking back at the brilliant array of my predecessors—great scientists, distinguished industrialists, and eminent statesmen, I am also made conscious of the great responsibility which the election to this office entails. On receiving the news of my election, I wondered whether I would be able to do justice to the task assigned to me. I accepted with great humility and with doubts of my ability to succeed worthily that great statesman and foremost national leader, Prime Minister Pandit Jawahar Lal Nehru. I was, however, encouraged by the thought that in carrying out my duties, I shall have the full support and collaboration of the body of eminent scientists and others associated with this great organisation.

The venue of the congress in Patna is of personal interest to me. It was during 1929-30 that the Patna University invited me to deliver a course of lectures in connection with the recently founded Sukhraj Ray Readership in Natural Science. As at that time, I was engaged in the study of the rationalisation of the use of the materia medica of Indigenous Medicine, I selected it as the subject of my lectures. To-day, in my address on the *Rationalisation of Medicine in India* I propose briefly to review the work done since and to indicate how this study is likely to help in replacing the empiricism current in medical practice by a system based on scientific research and verification, *i.e.*, a rational system.

INDIGENOUS MEDICINE

Zenith of Development.—The development of medical science in India is a fascinating study. The ancient Hindu System of medicine has not only provided relief for the past many centuries, but is still doing so to large sections of our people over vast areas of this great country. Ayurveda, which is stated to have been written about 2,000 years B.C., formed the foundation stone of medicine in India. Later on such works as Charaka and Susruta, and many others dealing with such subjects as anatomy, medicine, surgery, gynaecology and obstetrics, made their appearance. The

human body was dissected and attempts were made to understand the functions of important organs. A close study of the literature of that period reveals the strength and extent of scientific knowledge of ancient India regarding the diagnosis and treatment of the diseases then prevalent. Early records indicate that the immunity to small-pox conferred by cow-pox was known in that age. The therapeutic agents used were both of organic and inorganic origin. It has been shown that even anaesthetics, administered both by the mouth and by inhalation into the lungs, were used for surgical operations in the early part of the Christian era. Particular attention was paid to dietetics, and dietary was carefully worked out with due regard to individual susceptibilities and according to variations in times and seasons of the year. About this time, Hindu Medicine had attained its highest development and there is evidence to show that it permeated far and wide into Egypt, Greece and Rome, and played an important part in moulding both Greek and Roman medicine, and through the former the Arabic system.

Decay.—As invariably happens, dacay set in with the passage of time, and during the first millennium of the Christian era Hindu medicine became not only sterile but waned and declined in its standard of efficiency. When the Muslims invaded India, they brought their own healing system; this gradually gained ground in the country and became the State System of medical relief. Muslim medicine had been greatly influenced by Greek medicine, as it reflected in the name Unani (Greek) by which it is generally known in this country. It brought with it rich stores of materia medica derived both from the Arabian and the Greek sources hitherto unknown in this country. The Arabs also had made great advances in the domain of chemistry, and their materia medica had as its basis the generally accepted scientific doctrines of that period.

In its turn, with the decline of Mohammedan rule in India, Muslim medicine also suffered a set back and made way for the Western System of medical relief, which was introduced by the advent of the Europeans. The new European system gradually found its way to the people, and appreciation and demand for it extended universally all over the country. Particularly this was due to its surgical achievements; at the same time its more systematized and standardized materia medica supplanted to a great extent the heterogenous indigenous drugs in use.

In the evolution of practice of rational medicine in this country, we have, therefore, to consider the effects produced by the impact of all these factors.

Present Position.—What is the present position of indigenous medicine from the utilitarian and scientific aspects? It is generally believed that Ayurvedic medicine had remained sterile for many centuries. During this period, much of the old literature was either mutilated or lost, and degeneration set in in all its various branches, particularly in surgery, gynaecology, etc. The practice of medicine was restricted at first to the Priestly Class and then to certain sub-castes, who on one side believed that as the Ayurveda was an inspired science, it was not possible to improve on it further by the wisdom of man. On the other hand the touching of dead body was regarded as polluting and, therefore, sinful, and the dissection of bodies was given up, the result was that studies of such basic subjects as Anatomy and Physiology were altogether neglected. The effect of ignoring these basic studies particularly on surgery can well be imagined. A large number of

drugs were, however, introduced during the late Buddhist period and properly equipped hospitals and a well-organised system of State medical relief was instituted. But with the decline of Buddhism deterioration set in all round in knowledge, teaching and practice of medicine. Not only was information regarding many drugs lost, but recognition and identification of a large number became impossible. This was a great loss to Ayurvedic medicine, and whilst there undoubtedly is reason to be proud of its glorious past, it is not possible to view its present condition without a sense of apprehension.

It has been my good fortune to come into contact with eminent scholars and practitioners of Indigenous Medicine, some of whom have also studied the Western Medicine. They are equally concerned with the decline and sterility of the system but consider that as there is much in common between the old and new ideas concerning the etiology, pathogenesis and treatment of disease, the restoration and development of the Indigenous system would not be difficult. The old theories of causation of disease according to them can be justified in the light of recent advances in scientific medicine. Some even claim that there are indications that the old Hindu medicine had knowledge of the bacterial origin of disease, and that even the role of viruses was not unknown. They point out that in their system more attention has rightly been given to the state of the soil, that is, the body, than to the seed of disease, that is, the micro-organisms which become engrafted on it. In recognizing the importance of this soil factor, which has now been appreciated by Modern Medicine, Indian Medicine was undoubtedly centuries in advance of the Western. The eminent scholars and practitioners of Indigenous Medicine, however, realise fully the need for investigation and research, if their system of medicine is to be brought into line with the present day requirements. For with the lapse of time and changes in environments some diseases have become modified and perhaps their aetiology and pathology altered. While some of the old diseases have disappeared new ones have come in. The great advance recently made in treatment too cannot be neglected. Unless fresh knowledge is acquired, their practice would be at a grave disadvantage. Unfortunately, very little has been done so far in this direction. Many among the orthodox Vaidas still believe in the divine origin of Ayurveda and resent the introduction of any innovations. They have resisted all attempts at the inclusion of new ideas and even of considering the possibility of any improvements in the practice of their ancient system.

The position with regard to Tibbi medicine, both as regards its theory and practice, is no better than that of the Ayurvedic medicine. What has been said about the present day status of Ayurvedic medicine applies with equal force to the literature and practice of Tibbi medicine.

That there is much in the Indigenous Medicine, especially in its materia medica, which can contribute to the well-being of the people of this country, is beyond any doubt. Eminent Western scholars and the medical men have borne testimony to their efficacy and usefulness. But with such a background as has been described above, Indigenous Medicine, it is believed, cannot play as effective a part nor take its proper place in the present day medical relief in this country, as its exponents would claim, and the people would rightly expect them to do. They will first have to put their house in order and become cognisant of the present-day environments and their requirements. The practitioners will have to be properly trained, and unauthorised practice will have to be rigidly eliminated. The true spirit of research and discovery

will have to be inculcated and irrationalism excluded from diagnosis and treatment of disease. The discoveries which have proved effective beyond doubt in the treatment of disease must be accepted and incorporated, and all inherent prejudices discarded to achieve the one sublime object of the alleviation of human suffering.

MEDICAL RELIEF TO THE MASSES

Mode of Relief.—At the present time in this vast country, medical relief to the masses is carried out by two agencies—(1) Indigenous and (2) Western:—

(1) Indigenous Medicine is being practised by a vast number of practitioners. Unfortunately only a small portion of these have received any proper systematic training in educational institutions set up for the purpose Of the rest a few may have acquired some knowledge through connection with families which have either practised this art for generations or through having sold medicines. By far the largest number, however, have received no training whatsoever. Most of them collect an assortment of medicines and sell these to the ignorant and credulous masses. Many of them are wandering pedlars who carry their stock-in-trade of medicines with them from place to place. Their nostrums have the virtue of cheapness no doubt, but they cost the people very dear indeed. There is evidence to prove that they are responsible for producing much misery and suffering. But it is this very class which at the present time attends to the needs of the major portion of the population, particularly in the rural areas which are so inadequately supplied by properly trained practitioners of any system. There are however, some important considerations in favour of the Indigenous Medicine if it is properly practised. The first is that the materia medica used is derived entirely from indigenous sources, and therefore, is inexpensive and suits the people whose economic condition is low. The second is that these systems are ingrained among the people who have faith in the treatments prescribed and the drugs used. Some even consider that it suits their constitution better.

(2) The second agency of medical relief is through practitioners of Western Medicine. This system of medicine has been in vogue in India for nearly a century and a half, and is the form of relief recognised by the State. Though it has a scientific basis and is, therefore, much more amenable to rational practice, it unfortunately does not reach much more than 20 per cent of the population of this vast country in spite of all efforts that have been and are being made to extend it.

The reason for this tardiness is not far to seek. The economic condition of masses of the people is very low and there are millions who cannot afford any kind of treatment whatsoever, cheap or expensive. Consequently, they have to depend on charitable medical relief institutions which, considering the extent of the population, are not only too few in number but are so situated as to be available only for limited areas of the country roundabout. The cost of medicaments is so high that most of these institutions with limited annual budgets, are not able to cope with the demand for common essential drugs, to say nothing of the expensive medicines which are sometimes necesary and are even indispensible. For these reasons, but chiefly on account of its costliness, the practical utility of Western Medicine for medical relief on a very large scale has been limited.

In any scheme of rationalisation and extension of medical relief to the masses, all these factors will have to be carefully considered without prejudice for or against any particular system—medical relief on rational lines and on as extensive a scale as possible being the prime and only consideration.

Irrational Practice of Modern Medicine.—Quite in contrast to the Indigenous Medicine, Western Medicine has made enormous strides, both in connection with the causation of disease and its treatment. This is not the place for me to go into details of the progress which has been made during recent years, but its effect in relieving human suffering has been remarkable. So far as the application of these discoveries in actual diagnosis and treatment of disease among the teeming millions of this country is concerned, it must be admitted that the general practitioner has lagged far behind the times in his knowledge and equipment. This position is unsatisfactory and regrettable. It has been my painful duty to point out, from time to time, the tendency of practitioners of Western Medicine towards mere empiricism. The remarkable progress in the ætiology, physiology and pathogenesis appears to lose its significance, and makes little appeal to them in the actual practice of the healing art. Diagnosis is still made on empirical basis in the majority of cases. Non-critical and irrational use of therapeutic agents is rather the rule than the exception. In part this is due to the fact that medicine is mostly taught through European and American text books and is practised without making due allowances for climatic and other environmental factors. The ideas regarding diet in disease run counter to the beliefs held by people and are often repugnant to their social and religious susceptibilities. In fact if the state of medical practice in India is examined without prejudice, one is forced to the conclusion that with the exception perhaps of a small number of institutions, such as large hospitals and colleges and of a comparatively small number of practitioners, the practice of Western Medicine is not even a shade better than that of Indigenous Medicine. And one dare not estimate the harm that has been done through indiscriminate use of powerful remedies which science has placed in the hands of the practitioners.

In addition the outlook of the average Western medical practitioner of the present day is sadly restricted. While he is always crying down indigenous medicine, he takes no steps to improve the low standard of his own practice. The charge of irrationalism applies as much to him as to the practitioner of indigenous medicine. Pandit Jawahar Lal Nehru, while inaugurating the meeting of the Conference of Physicians last year, criticised the spirit of narrow trade unionism which dominated the medical profession in India. He exhorted the practitioners to keep in view the interests of the community as a whole and to help in building up a healthier and more prosperous India. This call was truly needed for public health is perhaps the most important item in the programme of a nation and yet its promotion is badly neglected by the medical profession in this country. It is a sad commentary on things that though Western medical science has been well established in the whole country for at least half a century, if not more, it has not yet succeeded in making the average educated men more health conscious, to say nothing of the uneducated and ignorant masses. Again, there is very little understanding between the medical man and the patient. The doctor often looks down upon the poor class of patients and does not accord them the sympathy and consideration which is their right. This is particularly the case in government and semi-government institutions. The resentment

often expressed in the press and elsewhere, bears ample testimony to this fact, and most of us are aware of it from personal observation also.

These are some of the potent reasons why an average Indian shuns the Western medical practitioner and prefers the more sympathetic and considerate Vaid or Hakim. How can rationalisation be achieved under such conditions? I say without the least hesitation, from my personal experience during the last forty years that I have discerned little progress in the rationalisation of practice of Western medicine generally in this country. But while I say this, I must also admit that the blame does not lie wholly at the door of the general practitioner.

WHY RATIONAL MEDICINE NOT PRACTISED

Financial Starvation.—One of the chief reasons why rational medicine has not been practised, is that those responsible for the Government of this country in the past have neglected the growth of the nation building health services. The *per capita* expenditure has, in the past, been absurdly low as compared with that what should have been spent. The Bhore Committee on Health Survey and Development has pointed out that even after making due allowence for the much higher national incomes in countries like Great Britain and the United States "India should have spent annually Rs. 3|3|- per head of the population if her expenditure on health services were to bear the same relation to the national income as the amount spent in Great Britain in 1934-35 on health measures bore to her own national income. On the basis of a similar comparison with the United States, India's *per capita* expenditure on health, should have been Rs. 2|5|-." In comparison with these figures the combined expenditure on medical relief and public health activities in the provinces during 1944-45, ranged between 2.8 annas *per capita* in the Central Provinces to 10.9 annas in Bombay. Is it, therefore, surprising that medical education and medical research which form the foundation of rational medicine have suffered seriously? The teaching institutions are too few and many of those that exist are poorly equipped and inadequately staffed. The teaching of such important subjects as physiology and pharmacology the science of action of drugs, on which mainly depends the progress of medical treatment, is highly defective. Others such as pathology and bacteriology are no better. Practical instruction in most subjects leaves much to be desired. Hospitals and dispensaries are few and far between, and lack modern facilities and appliances, and the number of practitioners is far below that required for adequate relief.

Medical Education.—Medical education should, therefore, be carried out on much broader and sounder lines than heretofore if the present low standard of medicine in India is to be raised. This can only be done by improving the educational institutions, both as regards their teaching staff and equipment. No doubt, this will mean enormous expenditure, but it is expenditure that will repay itself many times.

The system of letting all the clinical teachers indulge in private practice has led to much abuse and neglect of their teaching duties. Such practice in State-supported hospitals has given rise to most reprehensible differential treatment of patients. While it is desirable that a few of the senior teachers may take up private practice and bring the exeperience from that particular type of practice to the student, its indiscriminate indulgence by all teachers has done incalculable harm to medical education.

Then, large sums of money are being spent at present on students going to foreign countries for obtaining qualifying medical degrees. If our own educational institutions were improved this drain would stop. Facilities for post-graduate studies should be very considerably increased and medical graduates encouraged to take these courses frequently. This can best be done by sending selected teachers to progressive countries to receive advanced knowledge and after their return to disseminate it among the medical profession. Provision should also be made for sending abroad qualified individuals for training in specialised subjects so that this knowledge is brought to the post-graduate students. Exchange of lecturers and professors should be arranged with well-known institutions all over the world. With the object of training our own men in special lines experts in highly specialised subjects should be imported, for limited periods, into Universities and Colleges, irrespective of the cost.

Group Practice.—It is obvious that modern medicine cannot be practised scientifically and rationally unless the necessary expert personnel and facilities for diagnosis and treatment are available. Both these are sadly lacking at present even in large towns. During recent years the development of 'group practice,' that is, collaboration of specialists in different branches with all their resources in the diagnosis and treatment of disease, has become a very noticeable feature in America and in Great Britain. In the latter country, the proposed National Health Service will bring into being the health-centre, an institution which it is intended should provide the general practitioner with all modern methods of diagnosis and treatment. If the medical practice in this country is to be rationalised, adequate provision will have to be made on similar lines. A beginning on these lines was successfully made in the School of Tropical Medicine, Calcutta, some years ago.

Medical Research.—There is no doubt that rational medicine cannot be practised unless there is extensive medical research. Here again one is struck with amazement at the calousness and apathy of the Government of this country in the past, at the manner in which medical research was relegated to the background. The annual grant for medical research by the Government of India, till recent years, was only a paltry few lacs of rupees and even this was cut down through the disgraceful recommendations of the Inchcape Commission. The research worker is poorly paid and all the best talent goes to practice because it is more remunerative. You have only to see what importance countries like the U.S.A. and Great Britain, are attaching to medical research and the amounts they are spending for this purpose, to realise the importance of medical research in rationalisation of medicine. With all these disabilities it is not surprising that the standard of medical practice in India is low, and scientific or rational medicine has not been practised.

The immediate implementing of a progressive plan like the one put forward by the Bhore Committee will enable us to draw abreast of recent knowledge and to introduce in our country up-to-date teaching and research and what is best in the health administration of advanced countries. Medical education, post-graduate studies and medical research will thus be brought to the level in the progressive countries. This will mean that the expenditure on health measures which has hitherto been in the neighbourhood of the absurdly low figure of about 6 annas *per capita* per annum, will be increased to 2.5 rupees a year. Even when this has been done India would be spending

on public health only 15 per cent. of her national income (Central and Provincial) as compared to the 25 per cent. spent by Great Britain. But increased expenditure is the only method which will eventually give the country an up-to-date health organisation and medical relief on scientific basis.

Trained Personnel and their Retiring Age.—Trained personnel is the first most important single factor for provision of adequate medical relief on rational lines. India possesses not more than 40,000 trained medical men and this works out about one doctor for 10,000 of population. Even this proportion does not give a correct idea because most of this personnel is concentrated in large towns. Look at it any way you like, the present number available is entirely inadequate. For adequate relief necessary for rationalisation there should be at least one medical man per 1,000 of the population. In fact in advanced countries there are two or three per 1,000. Thus we need at least ten times the number we have and it will take at least 30 to 40 years to train sufficient men for our need. It is imperative, therefore, that we do make the most of what we have. The present retiring age in regular services and elsewhere is considered to be 55 years when most of the incumbents are yet fit to carry on efficiently for many years. They should be made to work as long as possible and, if necessary, their sphere of work should be changed to suit their physical capacity.

When we come to highly specialised workers, such as Research Workers, of whom we have a still less adequate number, it would be foolish to retire them as is the usual practice at the age when they are most valuable for training other workers, organising new institutions and directing the activities of younger workers.

The retiring age of 55, which is now treated in the country as an unalterable law, was fixed by a foreign Government for Imperial Services staffed largely by foreign workers. They wanted them to go back Home, live in comfort or carry on efficient work for many years at our expense. What I am saying about medical workers applies with equal force to other scientific and techincal personnel. There is no other country in the world where other than mannual workers are retired earlier than 65 years.

THE ROLE OF INDIGENOUS MEDICINE

Bhore Committee.—The Bhore Committee considered in detail various aspects of public health and medical relief, but left the part played by indigenous medicine severely alone. It was stated that the Committee was not in a position to assess the real value of indigenous medicine as practised to-day. They stressed, however, that certain aspects of health problems could be secured wholly or at any rate largely, only through up-to-date scientific medicine and that indigenous medicine could not give much help here, as preventive medicine or public health was its weakest feature at the present time. The Indignous Medicine does not also, at present, deal with such vital aspects of medicine as obstetrics, gynæcology, advanced surgery and other highly specialised subjects. Further, no system of medicine which is static in conception and practice and does not keep pace with the discoveries and researches of scientific workers the world over, can ever hope to give the best ministration to those who need its aid. The Committee, therefore, recommended that "it should be left to the Provincial Governments to decide

what part, if any, should be played by the Indigenous Systems in the organisation of public health and medical relief. It is for them to consider, after such investigations as may be found necessary, under what conditions the practice of these systems should be permitted and whether it is necessary, either during some interim period or as a permanent measure, to utilise them in their schemes of medical relief." The criticism offered is very cogent and awaits an answer by the exponents of Indigenous Medicine.

The scheme envisaged by the Bhore Committee, admirable as it is, is bound by its very nature to take a considerable time to mature. The question, therefore, is whether things should be allowed to drift as they are drifting while a perfect system is being evolved or should anything be done in the interim period to improve the existing inadequacy of medical relief by using the Indigenous System? And if something is to be attempted, what line should it take?

Popular View.—There are many thinking people who consider that while a comprehensive and rational system of public health is being evolved, use should be made of Indigenous Medicine. Indigenous System—good, bad or indifferent as it may be—still caters for the needs of the major portion of the population particularly in rural areas. They, therefore, consider that it cannot be excluded altogether from the field, and urge that it should be used to the best advantage while the process of evolution of a perfect system of rationalisation of medicine is being worked out. During this transition period, they also hope that Indigenous Medicine will overhaul itself and become an integral part of the permanent system evolved.

If the existing state of affairs is considered without prejudice, there would appear to be a good deal of justification in favour of this course. Indigenous Medicine should be given a fair opportunity to overhaul itself, to discard what is useless, and to bring up-to-date, in the light of modern discoveries, what is intrinsically efficient and useful in it. It is also to be remembered that the people who still use Indigenous Medicine do not all belong to the ignorant and the uneducated class. A portion of the high intelligentsia in the country, who can think for themselves, believe in its efficacy, and it is reasonable to suppose that they must be getting some benefit out of it to think in this way. One is, therefore, forced to conclude that Western Medicine has not attempted to understand the Indigenous systems, and has been carried away by the inherent prejudices of the foreigners who have hitherto controlled the destinies of medical relief in this country. But while one can understand the European medical practitioner not understanding the value of Indigenous Medicine, it is not possible to endorse the views of the Indian practitioners of standing, when they assert that no notice should be taken of it, as it is archaic and obsolete, and therefore more or less useless. This attitude shows a lack of appreciation of the fundamentals and practice of their own system, and makes it essential to reorient their ideas with regard to the extension of medical relief.

SYNTHESIS OF MODERN AND INDIGENOUS MEDICINE

I have always held that some of the distinctions drawn between the various systems of medicine practised in this country and which have given rise to the prejudices in the minds of the advocates of one system against even the good points of another, are unreasonable and unscientific. The universal and cosmopolitan nature of medicine does, of course, vary according

to environment, and with the advance of knowledge necessary adjustments have to be made. But the only solution for rationalisation of medicine is the evolution of a country-wide extension of a system, which can be regarded in the words of the Bhore Committee, "neither as Eastern nor Western but is a corpus of scientific knowledge and practice belonging to the whole world to which every country has made its contribution."

Regarding this question I feel that a thoroughgoing synthesis may, at present result in the almost complete submergence of the indigenous into the Western system. For, the Western system is based on the surer foundations of biological and physical sciences, and has all the recent facilities for diagnosis, cure and prevention at its command. Moreover, any real synthesis will take many years to work out.

The Indigenous system, on the other hand, is cheap and suits the pockets of the poor, and being widespread, serves a very large number. Under modern democratic conditions the State too can not be indifferent to what is popular with its people. Such a cheap and popular system can not be ignored and we must consider whether the building up of efficient health services in the country can not be extended and accelerated through its addition to the State-sponsored Western system.

Western medicine, which at present dominates the country and is the system recognized by the State, should discard its narrow outlook of contempt for anything which is not its own. The Indigenous medicine, on the other hand, should discard its inherent prejudices and bring itself up-to-date by incorporating from other systems all that is of value. The practitioners of indigenous medicine should understand that in these days no claims of esoteric knowledge can be entertained, nor origin, antiquity and fancied utility urged as justifications.

Is a Synthesis Possible?—In connection with the rationalisation of medical practice in India two important questions suggest themselves. Firstly, can the practice of medicine be so regulated by the exponents of modern and of the indigenous systems that the fullest possible use is made of the facilities available for diagnosis, treatment and prevention of disease? I have already alluded to this. The second question is, can a synthesis of indigenous and modern systems of medicine be attempted so as to promote the utilisation of the knowledge from all available sources for the interpretation of health and disease and for diagnostic, curative and preventive purposes?

A Partial Synthesis.—I believe that both extension and acceleration are possible through what may be called a partial synthesis of the two systems, in the elementary stages of our teaching. The present course of study in the indigenous medicine should be suitably curtailed on one side and enlarged on the other. On the side of curtailment, I suggest that the teaching of subjects like Anatomy, Physiology and Pathology should be reduced to some extent. Their inclusion, on the present scale, in the curriculum of the Indigenous medicine leads to considerable confusion in the minds of the students. In passing, it may be mentioned that this reduction in studies will go parallel to the reduction in the studies of students of Western medicine, as proposed by the Bhore Committee. On the side of enlargement, I suggest that in addition to the basic principle of Ayurveda and Unani the students should be taught the basic principles of Western medicine. They should also be given training in preventive health measures.

The net effect of this suggestion will be twofold. It will shorten considerably the period of study and thus lead to the training of a much larger number of qualified practitioners. And, secondly while giving the students a sufficient background of scientific knowledge with regard to the diagnosis, treatment and prevention of disease, it, at the same time, will make them conscious of their own limitations, and of the necessity to appeal to higher practice in difficult cases. There are about a hundred thousand practitioners of indigenous medicine in India, many of whom could be quickly fitted for this purpose after suitable training.

Those who are likely to object to this curtailment and partial synthesis, should bear in mind that nearly 80 per cent of ailments are of a minor nature and can be dealt with by simple medical and surgical measures and require no advanced knowledge of the theory of diagnosis and treatment. Moreover, the suggested training will enable the practitioner to become an integral part of the health services, and thus the administrative difficulties now being experienced in some provinces through a dual system of medical relief will be avoided.

The services of such practitioners will be of particular value in the rural areas, which are now almost beyond the reach of modern medicine. Rural medical relief will be considerably facilitated if some further steps are taken to standardise medical practice by prescribing uniform scales of drugs and medical appliances for institutions, their production in bulk and distribution under the auspices of the State. If all practitioners are properly registered and practice by non-registered practitioners prohibited, a reasonable standard of competence could be secured by prescribing and enforcing the necessary rules regarding an expeditious system of training and examination in respect of their qualifying diplomas.

RESEARCH IN INDIGENOUS MEDICINE

Importance of Research.—Nothing can remain static in this dynamic universe, and the ever-changing world needs every-changing methods to deal with its ever-changing problems. Indigenous medicine can be no exception to this rule. While this partial and workable synthesis is taken in hand, I would earnestly suggest that careful research be made by the exponents of the indigenous medicine so as to link their system with the modern medicine. There is nothing derogratory in this. But the work can only be taken up by the learned Vaids and Hakims and is bound to take time; and yet, if this is not done their systems are bound to become entirely obsolete. The process of rationalisation of their materia medica should be comparatively easy, and has already been taken up by a number of workers outside these systems.

A reference has, however, to be made here to the unreasonable attitude adopted by some of the indigenous practitioners towards the workers outside their own fold. They consider that investigation of their drugs by methods of chemical analysis and biological testing developed by science, serves little purpose. It is opined that there is something mysterious in the action of "whole drugs" which cannot be investigated or elucidated by such tests. It is possible that there may be some such factors. The discovery of antibiotics and hormones in plants to which no importance was previously attached may lend support to these views. But these should be explained and the mystery cleared by efforts of the exponents in the light of present

knowledge. If they do this, a complete synthesis will not be a remote possibility. If they fail, the world outside cannot be blamed if it refuses to believe their theories. The present day world cannot accept any fantastic views whatever be their origin and however strong their following. The result will be their complete extinction in the course of time.

The outside workers should not be depressed by the hostile attitude and should go ahead. Every little contribution adds to our knowledge and may help materially towards the alleviation of human suffering

I now give some concrete suggestions for Research in Drugs, in Indigenous Materia Medica, for Drug Standardisation, Manufacture and Control which are essential for rationalisation.

DRUGS AND MEDICAL REQUISITES

Central Institute for Drug Research.—My first suggestion is that a Central Institute for Drug Research should be established at the earliest possible opportunity. The lines on which the Institute should work have already been endorsed by the Council of Scientific and Industrial Research. The Institute will ensure the fullest collaboration between all the allied sciences concerned in drug research, between the scientists themselves, and between them and the industry. By rationalising the Materia Medica, the Institute will help considerably the rationalisation and extension of Medical Relief all over the country and particularly in the rural areas.

It is worth recording that the beginnings of this work were laid down by me more than a quarter of a century back at the School of Tropical Medicine, Calcutta. As a result of the activities at that School, botanical identification, chemical analysis, pharmacological studies and clinical trials of a large number of commonly used drugs have been completed. Rational explanation with regard to the efficacy of some of these drugs has thus been forthcoming, and a number of these drugs are now largely used by medical practitioners in the country. But only the fringe of this vast subject has yet been touched.. It would be for the proposed Institute to take up this work on an extensive scale in all its details.

All sections of the Institute should be liberally staffed and generously equipped. It should perform the dual function of investigating the indigenous materia medica on scientific lines so that it can be brought into more extensive use, and of synthesizing and evaluating, with special reference to the requirements of this country, the new remedies which are being daily introduced by scientific organizations and firms of repute. In so far as these remedies are essential for the welfare of the people, economic commercial processes for their manufacture should be worked out immediately. Had such an institute been established after World War I, the acute shortage of drugs which was experienced during the World War II would not have occurred. The country would have been self-supporting with regard to medicinal agents of every description. Further the price of drugs would have been brought down to the economic level of the people. Such a scheme does not preclude the existence of individual foci of research in universities and other research organisation; on the other hand these should be encouraged more than ever. This Institute should also be independent of the work envisaged in the Drug Control Laboratory, and in the Divisions of Biochemistry and Biological Evaluation of the National Chemical Laboratory.

The Central Institute should have a fully equipped special section in which the exponents of the indigenous medicine can work in their own way, rationalise their materia medica and demonstrate its efficacy to the world.

The reason why a Central Institute has not been brought into existence is that the vested foreign interests wanted this country to remain the largest dumping market in the world of all kinds of drugs, good or bad.

Panel on Drugs and Fine Chemicals.—The Bhore Committee, to which I have already referred, gave serious consideration to requirements of the country as regards essential drugs and other medical requisites. They considered that for the better medical relief organisation of the country, the therapeutic substances and medical appliances came second in importance only to the adequate number of personnel needed by the country and they stressed the extreme importanc of making the country self-supporting as regards drugs and medical requisites of every description. ~~They~~ pointedly drew attention to the disruption of the medical relief organisation of the country brought about by the shortage of drugs and medical appliances caused by the War. They strongly felt that India must never suffer that fate again. They brushed aside the usual arguments advanced against the manufacture of drugs and medical appliances in the country, such as that the cost of production in the countnry would be greater or that the raw materials for the manufacture of drugs were not available in the country or that certain drugs and appliances were of such a highly specialised character that they would take long to produce in India and then the difficulty of patents. They considered these arguments and came to the conclusion that these objections made it all the more important to plan on a wider basis. India has enough talent and more than enough, and if it is properly exploited, it could match production anywhere. They definitely stated that the lack of raw materials for making synthetic drugs in India was an additional reason why in addition to the drugs the raw materials should also be produced in the country and they saw no difficulty in such a manufacture being made a success. However, they recommended that an ad-hoc committee should be appointed by the Government of India to go into the question.

Such a Committee was instituted by the Planning and Development Department of the Government of India in 1945 under my chairmanship. On this Panel for Fine Chemicals, Drugs and Pharmaceuticals were represented the leading scientists and the representatives of the important drug manufacturers in the country, and the services of an eminent consulting chemical engineer from the U.S.A. were made available in an advisory capacity. This committee thoroughly went into the question and produced a valuable Report in 1946. I particularly want to draw your attention to some of the salient recommendations made by the Panel. The country must produce all essential drugs and make them available for use of the masses at economic prices. It was specifically recommended that the manufacture of two types of drugs should be undertaken immediately, namely (1) those which are essential for guarding the health of the public and warding off infectious diseases and (2) those for which India already has or can easily develop raw material in abundance. Under the first category come sulpha drugs, antimalarials, antibiotics like Penicillin, Streptomycin, etc. The arsenicals and D.D.T. can also be included in this list. The Panel recommended that the manufacture of these drugs should be taken up immediately and recommended that Government should take up the initiative and put up

the first plants which should serve as models. I wish to draw special attention to this recommendation, and its full significance will be understood when you realise that the representatives of commercial firms, who were present, fully endorsed the view that the first plants should be put up by Government. These would serve as models for the industry and provide a training ground for personnel. Further, these drugs are needed by the poorest of the poor and they must be made available to the health authorities at the lowest possible cost.

In the second group come drugs of vegetable origin. The production of the drugs from vegetable sources, such as quinine, emetine, morphine, caffeine, ephedrine, santonin, essential oils, etc., should be developed to the fullest possible extent, both for the needs of the country and also for export. These drugs are literally to be treated as the wealth of the country and should be exported to good purpose.

Deputation to England and the U.S.A.—In consonance with the recommendation of this Panel, the Government of India deputed two distinguished scientists from the Haffkine Institute to go to England and America to explore the possibility of the manufacture of antibiotics, sulpha and antimalarial drugs. They returned to India by the end of November last year and submitted their Report to the Government of India, Department of Industries and Supplies. I have seen this Report and can say without hesitation that the Report is of great national importance for more reasons than one. In the first place, it gives complete data which are necessary for undertaking the manufacture of drugs and these data show clearly that all these drugs can be made much cheaper in India, at about 1|5th the cost, than they can be imported from abroad, and when the question of the treatment of millions of the poorest of the poor is involved, this is a matter of very important consideration. But the making of these drugs is not to be recommended solely on the grounds of saving money.

A Valuable Training Centre.—The making of drugs in the country in a State Institute would mean greatly increased production. If the drugs are manufactured in the country, we would have an excellent training centre, such as we do not possess at present. The Government of India is incurring a heavy expenditure for sending men abroad for training. It should be realised that no country abroad gives training in industrial production readily. Dr. B. C. Roy recently stated that though he could get promises of great deal of facilities for academic training of our men, he was not so successful as regards industrial training in manufacturing concerns. Here lies the importance of the scheme. We have workers who have gained the experience of production and have the necessary ability and are actually producing these drugs in a semi-commercial scale in laboratories like the Haffkine Institute. We should now put up a large plant under public auspices, which will provide those facilities for training which the country has so far lacked and without which the country will get nowhere. This will provide a first-class modern chemical plant and research laboratory for training for drugs and fine chemical manufacture. If such a scheme materialises, I feel confident that within a few years, we would train hundreds of new chemists and within a reasonable period, say 10-15 years, the country would become fully self-sufficient and would not have to depend on foreign import.

Vegetable Wealth of the Country.—The question of the manufacture of the second type of drugs I have mentioned above is equally important. Here

we have literally ready made wealth in our hands and in these days of lack of dollar credits, we can use this great wealth of the country to very good purpose for foreign markets. A start has already been made in this direction, only now the Government must take a hand and put the production on a proper basis.

I would, therefore, urge the Government of India to immediately consider these propositions and take steps to implement them. I have said before that even the Panel on which representatives of commercial firms were represented, had no hesitation in saying that the first plants for the manufacture of synthetic drugs like sulpha drugs and antibiotics must be put up by the State and now that we have the necessary knowledge and trained personnel, there is no reason why the interests of the country be damaged by delaying the implementation of the proposed scheme which is essential for the rationalisation of medicine.

RESEARCH IN INDIGENOUS MATERIA MEDICA

This work must be carried out in a systematic manner under the following sections:—

Identification of Plants.—The materia medica of indigenous medicine consists predominantly of substances derived from the vegetable kingdom and practically all the plants used, grow in India. In the investigation of these plants the greatest difficulty I encountered in the beginning was that many plants mentioned in the literature baffled and defied recognition and identification. The descriptions in the old texts were in such vague and general terms that it was often impossible to be certain whether the specimens obtained were of the drug described. The identification of drugs is naturally not possible until prominent characteristics of each plant are established. But the verbal descriptions, as given in the old literature, could not enable the botanist to identify plants and parts of plants which even in themselves do not invariably present the same characteristics and even the learned exponents of indigenous medicine cannot, with certainty, indicate which is the authentic specimen mentioned in the old texts. As a result considerable confusion has arisen in the literature of indigenous medicine. Again, many drugs are frequently sold under different names, and entirely different drugs often under the same name. Very careful and detailed enquiries had, therefore, to be made before a plant could be taken up for investigation. In the work of identification help was at first obtained from the works of Western writers of the 19th century such as Jones, Ainslie, Roxburg, Wallich, Dymock, Watt, and others, who had carried out laborious studies to classify these plants. This also did not solve all the practical difficulties that arose.

Bureau of Plant Industry.—The great handicap was that there has not been in this country a proper organisation corresponding to the Bureaus of Plant Industry in advanced countries which collect and keep the information concerning plants up-to-date and encourage investigation and research. The Botanical Survey of India (Economic Products Section) and Forest Research Institute (Minor Products Section) do some scattered work in this connection but the whole work must be unified and concentrated so that full collaboration with allied organisations can be established.

For collecting and supplying all information regarding plants, a Bureau of Plant Industry on the lines of that existing in the United States of

America and in the U.S.S.R. should be established under the Ministry of Agriculture. The Bureau in America can serve as a model. It carries on its activities under the Department of Agriculture in collaboration with agencies such as Bureau of Entomology and Plant Quarantine, Federal Crop Insurance Corporation, Federal Surplus Commodities Corporation, Forest Services, Office of Foreign Agricultural Relations, Agricultural Marketing Service, Food and Drug Administration, etc. Any organisation planning to stimulate the cultivation and development of medicinal plants in this country must collaborate with scientific workers in allied branches for the solution of inter-related problems. The functions which such a Bureau could usefully perform, are multifarious and should be worked out according to the requirements of the country. For example, it could collect and maintain up-to-date information with regard to all plants of economic importance by carrying out surveys and collecting statistical data regarding their export and import. It could have information with regard to new species which can be successfully introduced and commercially developed and about markets in India and abroad. It should have knowledge regarding the quality and quantity of drugs growing in a state of nature and which are and can be successfully cultivated. Substitutes of pharmacopoeial drugs which might serve the same therapeutic purposes could be investigated under this auspices and brought into use. The Indian drug trade has seriously suffered because the quality of drugs has not been maintained and adulteration has been rife. The Bureau could exercise quality control and regulate drug trade by establishing drug emporia which could act as a central clearing houses for authentic drugs. It should establish herbaria for the various types of economic plants. Detailed surveys of grass-lands and other localities would be the function of this Bureau so that measures for protecting live-stock against the menace of poisoning could be adopted.

Foreign Agricultural Relations.—The Section on Foreign Agricultural Relations should be an important part of this Bureau if a separate Bureau for this purpose is not established. This will help "in addition to other activities, medicinal plant culture by publishing statistical information showing the principal market outlets for such botanicals nearest to their point of production and by establishing liason with countries through diplomatic and other channels, for procurement of seeds and other agricultural information necessary for the acclimatization of a new crop of economic and industrial significance".

Herbarium of Medicinal Plants.—The section of Bureau of Plant Industry should have along with it a special section of Herbaria of Medicinal and Economic Plants. Herbaria are urgently needed for food and fodder plants, grasses and for plants poisonous to men and animals, edible and poisonous fungi, algae, mosses, etc. Knowledge regarding these plants is lacking at present.

There is, no doubt, a large herbarium in the Botanical Gardens at Sibpur, Calcutta, but the specimens are so mixed up that to look up for a specimen is like hunting for a needle in a haystock. In order, therefore, to facilitate the work on indigenous drugs, some years back, I decided to build up a reference herbarium containing authenticated specimens of all medicinal plants growing in the country. The collection of such a herbarium was slow at first, but was speeded up when grants for the purpose were sanctioned by the Indian Research Fund Association and the

Imperial Council of Agricultural Research. A well-equipped botanical unit was established for making collections of plants from all parts of India and for their proper preservation and identification. By extensive investigations and collections in the field and by laborious studies in all the existing local herbaria in different parts of the country, about 10,000 specimens of nearly two thousand of the common species of medicinal plants were collected. Several sheets of each species were prepared, and to ensure perpetuity and enhance and extend their utility to scientific workers, three more or less, complete sets of specimens were housed at the Forest Research Institute, Dehra Dun, the School of Tropical Medicine, Calcutta, and at the Drug Research Laboratory in Kashmir State. A few hundreds of the uncommon species have still to be collected and this is being gradually done; this work could be expeditiously done by the Bureau of Plant Industry. This Herbarium is already becoming known and is being used by scientific workers.

Survey of Medicinal and Poisonous Plants.—Side by side with the survey of the distribution of medicinal plants, there should be a section on Survey of Poisonous Plants and Food and Fodder Plants. A preliminary survey was made by me, years back. The exact habitats of plants growing in a state of nature or otherwise were verified during extensive tours and a lot of existing confusion was cleared up. Many of the medicinal plants are poisonous to man and animals, and in the course of the survey, notice was taken of those which have toxic properties but are not used in medicine. It was very soon realised that while much work had been done on this group in Europe, America, South Africa and other countries, no systematic work had so far been attempted in India.

But much remains to be done. The distribution of many plants as described in the literature of indigenous medicine in the latter half of the 19th century is often vague and inaccuracies which have crept in have passed from one book to another. Again plants may change their habitats and exotics may come in. Such a survey is, therefore, important not only from the point of view of distribution of medicinal plants but in other respects also.

Further, for the extension of medical relief on rational lines it is not only necessary to make a scientific study of these plants but to cultivate them for therapeutic use if need be. The only way in which it is possible to determine the areas of optimum production, with any degree of accuracy, is first to find out whether a particular plant grows well and in abundance or is scarce in any particular area. These studies alone can provide the basic information regarding the suitability of localities for the cultivation of different plants. The gradual development of such work has led to the cultivation of a number of plants of great utility with as good active principle contents, as are found anywhere else.

The medical and toxicological aspects of the Cryptogamic flora of India constitute an almost unexplored field. We have very little information about the deleterious effects produced by Indian algae. Many of the fungi such as rusts, smuts, etc., attack food and fodder, while poisonous mushrooms grow in many parts. Many more poisonous species exist than have been studied, and about these also little or no information is available. The same applies to liverworts and mosses of India.

Poisonous Plants and Insecticides.—So far as the Phanerogams (flowering plants) are concerned, two main groups exist: (a) the group of plants poisonous to man and livestock. This is a large one, and while considerable information is available about plants poisonous to man, knowledge

regarding poisoning of the livestock is meagre. India possesses roughly a third of the bovine population of the world and the question of its fodder supply is of utmost importance. Even in countries like America, where much is known about these plants, the figures of losses suffered through poisoning are high. Similar figures of losses are not available in India, but they are sure to be very high. Unless detailed information about these plants is available, preventive measure cannot be adopted. Grasses form an important part of the food of animals and some of these develop dangerously large quantities of hydrocyanic acid, flourides, etc., under certain climatic and soil conditions, especially in time of drought when plants have become wilted and stunted.

(b) The group of plants poisonous to insects and fish is also important in the economy of the nation. Insects do incalculable harm and are responsible for a considerable loss of life and destruction of property. On a moderate computation the annual loss caused to India through insect pests has been put at 2,000 millions of rupees and over a million and a half in human lives. An effective control of these enemies of social and economic progress will reduce this enormous loss and will facilitate national development. One means of fighting them is by insecticides which could be supplied by this group of plants. In spite of the development of cheap, synthetic and potent insecticides, such as D. D. T., vegetable insecticides still hold a prominent place, as they are less deleterious to warm blooded animals and plant life and possess immediate knock-out effects.

Cultivation of Medicinal Plants.—The acute shortage of drugs during the World War II drew attention to this important subject and a good deal of interest is now being taken to give it a practical shape. Most of the drugs required for therapeutic purposes are grown in this country. Those which do not grow can be grown in selected places. Among the exotics of great practical utility which have been successfully cultivated may be mentioned cinchona, ipecacuanha, digitalis, pyrethrum and others. It should be realised, however, that this is no novice's work but needs specialised knowledge and guidance of a scientific organisation. The soil, the season of planting, the gathering time, hybridisation, plant diseases, etc., are some of the important factors which call for expert attention in connection with the active principle of plants. The collaborative efforts of plant culturists, pharmacognosists, pharmacists, pharmacologists, entomologists and chemists, are essential and these could be made available only by such organisations as the Central Institute for Drug Research, Bureau of Plant Industry, Foreign Agricultural Relations Bureau, etc.

DRUG STANDARDISATION AND DRUG CONTROL

Rationalisation of medicine is not possible till the drugs in use are standardized and controlled. This applies with equal force to the drugs used in Indigenous medicine.

Adulteration.—It has been shown that a large number of drugs and pharmaceutical preparations marketed in this country, vary a good deal in regard to the potency claimed for them. While a certain amount of deterioration in active principles takes place through climatic factors and effects of storage, it has also to be admitted that often open and wilful adulteration of many remedies is being practised. To rectify this state of affairs, the Government of India appointed the Drugs Enquiry Committee of 1930-31.

under my direction. Investigation on an extensive scale showed that the position was even worse than had been believed. The Committee submitted its report early in 1931 but unfortunately legislation could not be enacted till 1940, and owing to the exigencies of War, it was not possible to establish the machinery for implementing it till April last year (1947). This legislation, while it is far from perfect, should help materially towards stabilizing the quality of drugs in this country.

The Committee unfortunately could not suggest any action with regard to the drugs used extensively in the indigenous medicine, although there was abundant evidence that these were extensively adulterated and were often of inferior quality. The main reason was that the active principles of many of these drugs had not been identified and, therefore, no standards could be laid down for their control.

The protagonists of indigenous medicine should realize that unless standards are established for drugs they use, either by their own methods, or by the generally accepted chemical and biological assay, the efficacy of their drugs cannot be guaranteed. Establishment of standards for all drugs and their inclusion in the Indian Pharmacopœia of the future is absolutely essential before such drugs can play an effective role in a rational system of treatment.

Indian Pharmacopœia.—A National Pharmacopœia is primarily meant to meet the claims and to satisfy the needs of a particular group of physicians at a particular time. The object of a pharmacopoeia is, in the words of founders of the United States Pharmacopoeia, "to select from among substances which have medicinal power, those the utility of which is most fully established and best understood, and to form from these, preparations and compositions in which their powers may be exerted to the greatest advantage". The modern pharmacopoeia is a book of standards, its fundamental objects are "to provide standards for drugs and medicines of therapeutic usefulness or pharmaceutic necessity, sufficiently used in medical practice; to lay down tests for the identity, quality and purity, to ensure, as far as possible, uniformity in physical properties and active constituents". In other words, usage—rational usage and scientific usage are bases of judgement. Such criteria are no less applicable to indigenous medicine as to Western or any other system of medicine wherever practised.

The Drugs Enquiry Committee considered the question of compilation of an Indian Pharmacopœia and came to the conclusion that there were cogent scientific reasons in favour of it. The methods of therapy vary in different countries. The raw materials from which medicinal preparations are made do not possess the same qualities, and may not be available so readily in one part of the country as in another. The effect of climatic conditions on the pharmaceutical processes has to be studied. Racial variations in dosage also have to be considered. For these reasons the pharmacopœia of one country is not always applicable to another country. It is essential, therefore, that each country should evolve a pharmacopœia best suited to its own peculiar climatic and racial factors. It should include the therapeutically active substances of known composition, of definite action, of well-established therapeutic use, of known toxicity, and with necessary standards for determining safe maximum dosages. In the case of the drugs in use, it is essential that requisite standards should be established for strength and purity of the materials which are to be used in treatment.

A Permanent Pharmacopœia Committee.—Such standards are being gradually worked out and have actually been evolved in case of a number of drugs used in the practice of medicine both indigenous and modern. It is gratifying to note that at last the foundation of such an essential work has been laid by the publication of an Indian Pharmacopœial List complied by a Committee appointed by the Central Health Ministry (formerly Health Department) of which I was the chairman. This work should be considerably extended by the proposed Central Institute for Drug Research and other research organisations. A permanent Committee should be set up on the lines of British Pharmacopœia Commission or the organisation in the U.S.A. to build up an Indian Pharmacopœia including all drugs of value in the practice of medicine in this country. This can be accomplished in the very near future if all facilities are made available. Such a Pharmacopœia is essential for rationalisation of medicine in this country and will act as a bulwark against the present tendency towards irrational practice.

REFERENCES

1. Chopra, R. N., Ghosh, B. N.; Field for Research in India, Indigenous Drugs; *Ind. Med. Gazette*, 1923, Vol. 50, p. 99.
2. Report of Drugs Enquiry Committee (1930-31), Government of India Press, New Delhi, 1931.
3. Chopra R. N.; *Indigenous Drugs of India;* The Art Press, Calcutta, 1933.
4. Chopra, R. N.; Indigenous Drugs Inquiry; A review of the work, Indian Research Fund Association, New Delhi, 1939.
5. Mukerji, B.; Planning for India's Foreign Trade in Vegetable Drugs, *Indian Pharmacist,* 1945, Vol. I, No. I, p. 31.
6. Report of the Health Survey and Development Committee, Government of India Press, New Delhi, 1946.
7. Chopra, R. N.; Indian Medicinal and Poisonous Plants; A brief review (1921-46), Indian Science Congress and Council of Scientific and Industrial Research, 1947.
8. Report of the Panel on Fine Chemicals, Drugs and Pharmaceuticals, Government of India Press, Simla, 1947.
9. Chopra, R. N.; Badhwar, R. L., and Ghosh, S; *Poisonous Plants of India,* in two volumes. Government of India Press, Calcutta. (in press).
10. Mukerji, B.; Scheme for Central Institute for Drug Research—Unpublished.

•SECTION OF ENGINEERING AND METALLURGY

President—N. SEN, M.MET., B.SC., F.R.I.C., F.I.M.

SOME DEVELOPMENTS IN FERROUS METALLURGY

(*Delivered on January* 5, 1948)

I wish to express my sincerest thanks for the honour you have done me in electing me to preside over the section of Engineering and Metallurgy of the Indian Science Congress this year. It is an honour which I greatly appreciate.

In my address I propose to deal briefly with some recent developments in the iron and steel industry. A great progress has been made throughout the whole field of ferrous metallurgy since the beginning of this century and to deal adequately with the subject as a whole would be tedious. I will, therefore, describe certain selected developments in the industry which have taken place comparatively recently, and indicate the assistance which has been obtained from the advances in scientific technique and knowledge during this time.

Metals are the chief material basis of the present industrial civilization. Some other materials stand higher than the metals as primary necessaries, in the quantities used, or in money value, but every kind of production, industry, transport and communication is now dependent on metallic tools, machinery and other equipment. The extent to which this dependence has increased in our lifetime is illustrated by the statement that during the first twenty-five years of the present century the world consumed a larger quantity of the metals than in all preceding time. Figures given by Sir Harold Hartley, in the 1933 James Forrest Lecture, for the world's productions of twenty-one metals in 1900 and in 1930 show that the production had at least doubled for all the common metals in these thirty years, whilst in some cases the increase was far greater; for example about thirty-six times as much aluminium was produced in 1930 as in 1900. In quantity produced, iron exceeds all other metals combined. The world is equipped today to produce not less than 150 million tons of steel per annum (this figure having been increased to more than 180 million tons during the war years) which sounds and is, a very large quantity. Steel is a complex metal and is without question the most versatile metal known to man. At present no rival exists which can challenge its position in the engineering field and it does not seem likely that future progress of metallurgical skill will bring any considerable change in this position if the facts are considered in regard to its potential supply, prospective cost of production, price to the user and versatility in use.

An intimate connection between metallurgy and the various branches of engineering has been the constant ruling factor in this ever-increasing rate of metal consumption, a connection so close that all progress in one branch is immediately reflected by progress in the other. The effect on the steel

industry of increasing engineering demands for still better steel and *vice versa*, the effect of these steels on engineering practice is a study of absorbing interest.

A century ago the metallurgy of iron was in a process of evolution; many works were still following methods which differed from those of preceding centuries in matters of detail only. The large industrial undertakings, which may be said to constitute the backbone of modern civilization were still in a rudimentary state but the principles of industry were already established and were solely awaiting favourable circumstances for production to reach in every respect the development we marvel at to-day. Among these circumstances one of the most important was the development in the manufacture of iron and steel to enable products to be provided which were suitable for requirements both as regards quantity and quality.

The modern tendency in the industry is towards the establishment of large integrated iron and steel works starting with the production of coke and going up to the manufacture of finished or semi-finished products such as billets, sections, rods, sheets and strip. The two most important items in the cost of producing steel are the cost of labour and of coal. Both are reduced by large scale production with continuity of operation. Liquid iron is transferred from the blast furnaces to the steel plant and the hot ingots from the steel plant fed to the rolling mills where the hot blooms often go direct to the finishing mills, thus preserving the sensible heat of the product. Simultaneously, the thermal efficiency of individual units has been increased with the net result that fuel consumption has been more than halved and labour costs appreciably reduced. The only fuel required for the operation of an integrated iron and steel plant is the coal which is used for the production of coke, the rest of the heat and power required being supplied by the coke oven and blast furnace gas.

This, however, depends upon the amount of finishing processes carried out. The economic size of such a unit mainly depends upon the type and diversity of the finished products required.

Much attention has been paid in recent years to the preparation of raw materials. For the most regular and economic operation of the blast furnace it has been found that there is an optimum grading of ore and this is much smaller than that formerly operated. Modern plants, therefore, have crushing and screening equipment to reduce the ore size to about 2 inches with the fines screened below ¼ inch. The object of this is to ensure that the ore instead of being reduced by solid carbon near the bosh is reduced higher up in the furnace by carbon monoxide, thus increasing the carbon efficiency.

The biggest development in recent years in blast furnace operation itself has been the adoption, where applicable, of the so-called "acid burdening process." Formerly when the coke was high in sulphur the lime content of the slag was progressively increased with the result that the melting point of the slag rose and with it the coke consumption. In the acid burdening proces, an acid slag is used having a lime: silica ratio of, say, 0.9 instead of 1.3-1.4. Thus the free-running temperature of the slag is reduced and the coke consumption considerably diminished. Although the sulphur content of the iron is high this can be rectified in one, two or three stages between the blast furnace and steel plant. These improvements in ore preparation and acid burdening have reduced the coke consumed per ton of pig iron produced by as much as 900 lbs.

The production of molten steel in large masses at a comparatively low cost was made possible first by the discovery of the Bessemer process which made steel a metal for general use and not a precious metal as it had formerly been. When Martin succeeded in melting steel on an open hearth with the help of Siemens regenerators it not only allowed of a higher quality steel than could be produced by the Bessemer process but it also came at the right time for utilizing all the old rails which then encumbered the railways and all the available crop ends. Then appeared a new invention of outstanding importance, namely the Thomas and Gilchrist basic process; this was first used with the Bessemer converter and then extended to the open hearth furnace. This invention made it possible to utilize the large deposits of phosphoric iron ores which constituted the greater mass of world ore reserves. This meant a revolution in the realm of metallurgical raw materials.

The acid converter is limited in scope, since it can only take low phosphorus, low sulphur haematite iron unless a duplex process is worked in conjunction with basic open hearth furnace. A notable advance in acid bessemer operation made in the United States during the war was the production on a very considerable scale of "killed" Bessemer steel of very high quality. This was commercially a new steel having interesting properties and representing the applied use of fundamental metallurgical knowledge which had become available during recent years. The temperature of Bessemer steel generally exceeds 1,600° C. At such temperatures carbon is a more powerful deoxidiser than silicon or manganese, particularly when the carbon content of the molten metal exceeds 0.1%. Efforts were, therefore, made to deoxidise blown Bessemer metal with carbon by adding hot mixer metal which contains apporximately 4% carbon as well as some manganese and silicon. It was found that the action of such additions to fully blown Bessemer metal gave a very quick and thorough preliminary deoxidation much like the "blocking" of an open hearth bath by the addition of ferro silicon or spiegel. The steel was then poured into a teeming ladle and the required amounts of manganese, silicon and aluminium added. Bessemer casts so treated were found to be thoroughly killed and of good forging quality.

Another noteworthy development in Bessemer steel which was worked during the war in Germany is the H.P.N. process. In this process the nitrogen content, which is normally between two and four times higher in basic Bessemer steel than in the open hearth steel, is controlled and reduced to limits comparable with open hearth steel. This is effected by reducing the bath depth, controlling the temperature and adding iron ore and lime towards the end of the blow. Several hundred thousand tons of steel were made by this process and by duplexing with electric furnace, alloy steels for springs and other armament work were made successfully.

Developments in open hearth practice have taken several lines, the outstanding tendency being towards installing large fixed furnaces and the fairly wide adoption of the venturi port and the sloping backwall. The fact that there has been no revolutionary change in design since Siemens built his first furnace is due in large measure to the limitations of available refractories. The most serious limitations are those of the roof and port bricks. A maximum roof temperature of 1,680° C limits the rate at which heat can be supplied to the bath whilst the necessity for good flame control has led to water cooled ports which not only consume water but remove considerable portion of the high temperature heat. The "all-basic" furnace *i.e.*; with a chrome magnesite roof appears to have demonstrated its serviceability in many plants

by leading to faster melting and longer furnace life but this still suffers from the disadvantages of high initial cost and greater weight.

The use of oxygen both in the blast furnace and in open hearth has recently been experimentally studied. In the open hearth oxygen has been used both for enriching combustion air as well as for carbon reduction. While the use of oxygen has much promise as a means of increasing output and reducing costs there still exist many major problems to be overcome before the full benefits of oxygen can be commercially realised. The recent development of improved methods of making oxygen from air on a very large scale and at the lowest possible cost by the use of the Kapitza turbine appears to have solved one of the most important problems in this connection.

The electric furnace, introduced in the beginning of the century, meant for the refined and special steel industry, an advance similar to that afforded by the Bessemer converter in the manufacture of ordinary class of steel. Had it not been for the electric furnace, which is more economical than the crucible especially in countries poor in coal but having numerous waterfalls, the price of special steels would have been prohibitive for many purposes.

During the War the production of electric furnace steel has increased enormously. For instance, American electric capacity increased from 1.5 million tons in 1939 to 7 million tons in 1944. The average unit size has also increased and several furnaces of 40 to 75 tons and even up to 100 tons capacity have been installed with an output equivalent to that of open hearth furnaces two or three times their size.

The use of electromagnetic circulation of the metal in arc furnaces is a very interesting recent development. It employs specially disposed coils in the hearth of the furnace, and by their aid it is possible to control both the direction and the intensity of circulation. This has been shown to be advantageous in increasing homogeneity in high alloy steels, and in hastening desulphurising and other reactions. This idea may be expected to be further applied especially on large furnaces.

In countries where fuel is scarce and water power plentiful, electrometallurgical industries are highly developed and in Norway, Sweden and Italy electric iron smelting is practised. Direct reduction processes are also being developed in an effort to eliminate carbon altogether. Using low-temperature hydrogen reduction it is possible to produce a sponge-iron cake which is afterwards melted electrically, thereby making steel without any carbonaceous fuel. When a supply of suitable high garde ore is available with water power for producing hydrogen by electrolysis this process can be operated economically. Although these processes are not of much importance at the present time from the point of view of quantity production of iron and steel, these methods are of particular interest to us being admirably suited to conditions in India where we have almost unlimited deposits of high grade iron ore and a restricted reserve of metallurgical coal but, nevertheless, high potential resources for developing hydroelectric power. It is very likely that with the future industrial development of our country these electric smelting and direct reduction processes will assume considerable importance in view of the acute national problem of coal conservation.

Developments in the rolling mill have been remarkable and metallurgists are amazed at the achievements of modern rolling mill technique where the ingot, slab, or bloom is hot rolled at such a speed that the finishing pass is

carried out above the recrystallisation temperature. This has mainly resulted from the advances in electrical engineering. Whilst taking up little space and being easy to operate motors are now built of considerable power, even exceeding 20,000 H.P. in the case of some reversing mills. The mills now have as accessories a whole series of automatic apparatus such as travellers, lifting platforms, skid rollers, shears and so forth which whilst making for increased output decrease labour costs. The rolling mill sheds have been lengthened and bars rolled are longer. Outputs exceeding 1,000 tons per 8 hour shift are of frequent occurrence.

The rolling mill has extended its realm beyond bars and plates and its extension to the manufacture of weldless tubes is one of the important conquests of metallurgy. Cold rolling has been a feature of the manufacture of thin sheets for galvanising and for the tinplate industry, and has made available for stamping out sheets of remarkable ductility and perfection of surface which are specially required for the manufacture of motor car bodies. The modern hot strip mill with its series of a number of stands in tandem taking slabs 4 in. to 5 in. thick and rolling them at a finishing speed of 2,000 ft. per minute is a great engineering feat involving vast capital expenditure and the auxiliary equipment, with its continuous pickling, washing and cleaning line, together with edge trimming, shearing, welding and so forth is equally complicated.

Forging tools have progressed on similar lines in regard to power, precision and ease of action.In recent times the forging press has replaced the hammer for heavy forgings, the hammer, whose action is more violent being retained for medium and small sized forgings only. There are now in different countries several quick acting forging presses of 15,000 tons, and even of 20,000 tons, capable of forging 250 ton ingots.

Though rolled and forged products account for a predominantly greater part of steel production, a considerable tonnage of steel is used for the making of castings. Casting liquid steel to shape is often the only method available for obtaining some of the complicated shapes both large and small that are required by the engineer. Advancement in the techinque of steel founding has kept pace with progress made in rolling and forging. As a result cast steel can be produced today with almost identical properties as the wrought product, and therefore plays an important role in the production line. The increase in the tonnage demanded by the engineer has been effectively handled by mechanisation in the foundry, improvement of existing and development of newer and faster methods. Of the newer methods that have come to stay mention should be made of 'centrifugal casting', which in its simplest form may be defined as the casting of metal under pressure of centrifugal force developed by high rotative speeds of specially prepared moulds. This method of producing castings has undergone a remarkable expansion during the war years. Use of centrifugal methods enables the production of castings more uniform in properties and with greater freedom from defects, and is applicable to a wide variety of products; from simple cylindrical shape like pipes to more complicated shapes like crank shafts and propellers.

The progress of metallurgy from the standpoint of quality has been quite as important as from that of quantity, if not more so, for, in regard to quality the work had to start absolutely *ab initio*. Science took its first steps under the auspices of analytical chemistry. The determination of carbon, phosphorus, sulphur and manganese brought out the influence which these

elements had upon the quality of steel and enabled methods of manufacture to be improved. Progress in the realm of chemical analysis has recently brought about a precise quantitative method for the estimation of total oxygen, hydrogen and nitrogen in steel. This method consists in heating a sample of the steel in a graphite crucible in high vacuum. Nitrogen and hydrogen are released, the oxygen and oxides react with carbon to form carbon monoxide and the gases are then collected and analysed.

One of the main tasks of the steel makers was to discover the causes of the defects which had long been their despair: these included piping, segregation, inclusions, blow holes, etc.; as a result it became possible to prevent them or at all events, to lessen their effect and thus to develop the methods of controlled production of high quality steels. Steel by virtue of its method of manufacture is heterogeneous, that is, it contains non-metallic impurities arising from the raw materials used and as reaction products resulting from contamination by furnace refractories. These impurities will, if present in massive form, lead to undesirable non-uniformity in physical properties. The degree of uniformity achieved in any particular case depends partly on the extent to which the impurities can be eliminated by the steel melter and partly on the extent to which their subsequent segregation and shrinkage during solidification can be controlled by careful casting technique.

During the last 20 years the application of the law of mass action to the reactions in the steel bath and between the bath and slag has led to a clearer understanding of steelmaking processes. Useful knowledge regarding the identity and quantity of the various inclusions present in solid steel has also been accumulated. The identification of inclusions can now be carried out by means of microscopic examination and the quantity determined by chemical analysis. The information available from the theoretical investigations and the practical data from gas and chemical analysis and microscopic examination have been absorbed into the steel melting technique with the result that cleanliness and uniformity are continuously improving. For example, electric steel is being produced regularly today having less than 0.05 per cent. of total non-metallic impurities including oxygen, hydrogen and nitrogen which can be considered as high degree of purity bearing in mind the difficult conditions as regards temperature of operation and the limitations set by the refractory materials comprising the working surfaces of steel furnaces.

The important problem of segregation during solidification has been studied systematically for the last 20 years by the Heterogeneity of Ingots Committee of the British Iron and Steel Institute and much valuable data obtained. It has been shown that for steel of given initial cleanness, segregation increases with increase in pouring temperature and increase in size of ingot. The actual margin available on pouring temperature is relatively small being about 50° C so that it is very important to be able to determine the temperature accurately. The Schofield Grace quick-immersion platinum platinum-rhodium thermocouple pyrometer which has recently been introduced after much research now finds extensive application in steel plants. This pyrometer can be accurately calibrated and is free from the uncertainty of emissivity corrections necessary with any form of radiation pyrometer.

The question of piping or central unsoundness arising due to the diminution in volume which occurs when liquid steel solidifies has been taken care of by using tapered moulds wide end up with a refractory head on top of the mould proper which provides a reservoir of liquid to feed the body of the ingot. The head is subsequently discarded and sound ingots obtained.

Thus we see that for steels of high quality suitable for the heaviest duty the steel melter produces a material of a very high degree of purity. This is cast into small moulds with a high degree of taper and having an adequate feeder head yielding an ingot of, say, 1 ton in weight. The resulting ingot is entirely free from unsoundness or shrinkage cavities and practically the whole of the segregates is moved into the feeder head. Where small ingots are inadequate in size and large ingots weighing up to 250 tons have to be used as for example in the manufacture of chemical vessels, rotor forgings, etc., segregation is minimised by careful attention to the steelmaking and choice of optimum casting conditions. Its position in the ingot is known within reasonable limits. Appropriate collaboration between the design engineer and the metallurgist then enables the forging operation and the subsequent machining to final size to be so arranged that the position of the segregates is located in regions where the working stresses are such that they can be tolerated.

Various new methods have been introduced for the inspection and non-destructive testing of the finished material for cleanliness and freedom from defects. X-ray examination which is generally called Radiography to distinguish it from X-ray crystallography, permits of a considered opinion being given on the homogeneity of steel without damaging in any way the piece under examination, and also brings to light internal defects such as porosity, blow holes and cracks provided their thickness is sufficient. This method of investigation is most useful for the verification of welds in plate work such as boiler work or high pressure pipe lines.

Where the highest quality weld is demanded from design considerations (class 1 welding) radiographic inspection of all welds is carried out as a routine procedure. This provides a check on the welding technique and defective sections are cut and re-welded.

The development of a satisfactory welding technique has involved a good deal of investigation and among the many factors that have contributed to the recent rapid development may be mentioned the marked improvements which have occurred in welding equipment, the degree to which certain types of operation can be rendered automatic, the saving of material, simplification in design, general convenience, and, not least, the realisation that welding, when properly controlled, affords a reliable and efficient joint for many purposes. Although in the hands of the expert welder the welding of steel appears to be a simple matter the operation is relatively complex from the metallurgical standpoint and it is not surprising, particularly in view of the long and satisfactory experience with bolted and riveted joints, that a rather conservative attitude has been displayed to welded joints and it is by such large scale testing of welded structures by radiographic method, by thorough mechanical testing of welds and by the introduction of suitable safety factors that this lack of confidence has been eliminated.

The procedure of radiographic testing, briefly, is to place the sample on a photographic film, and then irradiate it from a source of X-rays or gamma-rays. The radiation is absorbed by the metal and the amount of absorption is dependent on the thickness of the metal in the path of the beam and on its density. A cavity in a casting causing a reduction in the thickness of the metal to be penetrated gives a lower absorption of radiation and the film is consequently blackened to a grater extent beneath the cavity.

The wave length of the radiation is important because for penetration of a metal such as iron with a high density no great depth of metal can be

penetrated by rays generated at low voltages. With a pressure of 400 Kilovolts it is possible to obtain results only through thickness of 4 to 5 inches of metal. 1,000 Kilovolt units are now becoming available. The use of gamma-radiation from radioactive substances which has a wave length 50 to 100 times shorter than that of the X-rays permits very large thicknesses to be examined but the exposure times are long since the quantities of radioactive substances available correspond to very low power generators of X-rays.

Usually a defect with a linear dimension of, say, 2 per cent. of the thickness of the metal in the direction of the beam of X-rays can be detected with normal practice. Small defects such as fine cracks are not readily observed and for these purposes supersonic method of testing is to be preferred.

The use of supersonics has been introduced more recently. In this method a quartz crystal is set into oscillation by an electrical exciter and is then put into intimate contact with the metal part under examination. The elastic waves produced in the crystal are transmitted through the steel and reflected from the far end of the test piece. The reflected wave is received on a second crystal and its amplitude is recorded on a cathode-ray oscillograph. If any flaws exist in the path of the wave they produce subsidiary reflected waves which appear in addition to that resulting from the far surface of the test piece. The size of the defect which can be detected depends on the wave length of the oscillation set up in the quartz crystal and can be varied by suitable design of the electrical exciter.

Another method which is now being used extensively is what is commonly known as "magnaflux". This is particularly suited to revealing inclusions or defects in or near the surface. Such defects may act as stress raisers and are undesirable in components subject to high alternating stresses. The part to be examined is magnetized and is then covered with a fine suspension of magnetic material. Any discontinuity in the magnetic circuit such as an inclusion, is shown up by a segregation of powder in its vicinity.

I will not undertake to review, even briefly, all the different classes of special steel made available during the last 50 years. The number of binary, ternary and still more complex alloys of iron, carbon and various metals such as chromium, nickel, molybdenum, vanadium and tungsten now reaches a very high figure and the properties of all such alloys can be made to vary in innumerable ways by changes in the forging and thermal treatment processes to which they are subjected.

Among the most interesting alloys may be mentioned high speed steels. These alloys have revolutionised the mechanical engineering industry by allowing of rapid machining and thus increasing to an unsuspected degree the yield of labour and machine tools—a result which is not without its disadvantages from the social point of view. It is stated that Taylor and White made more than 50,000 experiments before arriving at the best composition and heat treatment for the high speed tool steel which created a sensation at the Paris Exhibition of 1900, when for the first time a heavy lathe was seen running with the tip of the cutting tool at a red heat.

For a long time further development of tool steels was on empirical lines, a little of first one element and then another being added until improved properties were obtained. Now, largely owing to use of the methods of isothermal transformation it has been possible to analyse the separate effects

of various alloying elements on the rate of transformation on which hardening and softening depend.

The principles of heat-treatment of steel can be considered briefly in relation to the simple case of ordinary carbon steels. At room temperatures, the iron in carbon steels exists in the form of ferrite or alpha iron which crystallises with body-centered cubic lattice; at high temperature, the iron undergoes an allotropic change to austenite or gamma iron. Carbon is very sparingly soluble in ferrite but the solubility is considerable in austenite, so that when steel is heated through the allotropic change not only does the arrangement of atoms on the crystal lattice change from body-centered cubic ferrite to face-centered cubic austenite but also solution of carbon takes place. On slow cooling from this critical temperature carbon is precipitated and the slower the cooling the higher is the average temperature at which the precipitation of carbon occurs. If the sample is quenched there is insufficient time for breakdown to occur at the high temperature, the decomposition of austenite is delayed and occurs at a lower temperature. In this case a hard and somewhat brittle material is obtained—which is called martensite the hardness of which depends on the carbon content.

Martensite is an unstable product having a body-centered tetragonal structure in which the axial ratio increases with increasing carbon content. It is instructive to note that austenite, martensite and ferrite can all be considered as body-centered tetragonal structures differing only in axial ratio. Martensite accordingly may be viewed as an intermediate step in the transformation from austenite to ferrite, a step in which the interstitially dissolved carbon atoms of austenite are retained in supersaturated solution in such a manner as to prevent for a time the completion of the transformation and producing great hardness due to internal strain. The simple concept of martensite formation by compressing the height and increasing the cross section of the body-centered tetragonal lattice of gamma iron does not, however, explain the observed orientations of martensite and a theory of transformation involving a shearing mechanism has been suggested.

On reheating or tempering this martensite much below the critical temperature the hardness can be reduced and the ductility increased so that a wide selection of properties from a single steel can be obtained by suitable treatment. Such quenched and tempered steels have a high degree of toughness in comparison with air cooled material of similar hardness.

The introduction of the method of isothermal transformation used with great success by Bain and Davenport can perhaps be considered a landmark in the study of transformation rates which has provided quantitative data on the problems associated with the breakdown of austenite during quenching. In this method specimens are heated to a suitable temperature for the production of austenite and then quenched into liquid baths maintained at constant temperatures. If the temperature is one at which the ferritic structure is the normal stable condition there is a tendency for the austenite to decompose to ferrite and by dilatometric, magnetic and other studies the time after quenching for the beginning and end of transformation can be obtained. When these times are plotted against temperatures we get a Time-Transformation-Temperature curve (S-curve) from which it is found that the transformation in carbon steels begins and is completed in a short time at a range of temperatures in the region of 600° C. It will be clear, therefore, that unless the rate of cooling through this range is rapid during normal heat-treatment some transformation will take place at the higher temperatures.

and a fully martensitic product will not be obtained. This critical rate of cooling has been found to vary with the carbon content decreasing with increasing carbon content up to about 0.9 per cent. carbon and also with the grain size of the steel—coarse grained steel being less readily transformed than fine grained.

To produce thoroughly hardened structures in large sections it is necessary to make alloy additions. These alloying elements have the effect of increasing the time required for the transformation to begin and they also reduce the rate of transformation when it has begun; in other words they increase the hardenability of steel. The tendency for carbon to be precipitated in the higher temperature range is thereby reduced.

For the quantitative treatment of practical problems a quicker and more practical method of assessing the hardenability of steel which has found most favour in the United States is the end-quench test introduced by Jominy and Boegehold. The advantage of this test is that many of the major factors influencing heat treatment are, in effect, brought into one test so that the behaviour of a steel in a variety of sections can be assessed from a single test. In this test a suitably heated bar 1 inch diameter by 4 inches long is quenched by a jet of water directed at one end only. When cold, hardness measurements are made at points along the length of the bar and the results plotted graphically.

It has already been mentioned that the rate of cooling in the region of rapid high temperature transformation is important in obtaining full hardening and it will be clear that the rate of cooling also varies along the length of the Jominy bar. Actual rates of cooling at different positions can be matched with rates of cooling at the centre of bars of different diameter. A prediction can, therefore, be made of the size of bar which can be effectively hardened in steels of differnt type. When fairly complex steels are under consideration, the shape of the T-T-T curve is rather more complicated and Jominy's criterion for comparison may not be the only important consideration. Nevertheless, the data obtained by the test are very useful.

Attempts have been made to calculate the hardenability of a steel directly from its chemical composition and grain size. The method is extremely simple but unfortunately though certain steels appear to conform reasonably well with the theory, general experience indicates that calculated hardness values particularly for steels containing two or more alloying elements are frequently erroneous and some recent work carried out in England indicates that the problem of calculating hardenability from chemical composition is extremely complex and it is very unlikely that any wholly satisfactory method capable of easy application is likely to be developed.

An important factor which has emerged as a result of the transformation investigations is that the effect of alloying elements on hardenability is not merely additive but is multiplicative. The cumulative effect of small amounts of several hardening elements is much greater than a corresponding larger amount of one only. For example, molybdenum, manganese and chromium have very similar individual effects on hardenability; an addition of 0.5% of each is however roughly 2 or 3 times as effective as the addition of 1.5 per cent. of one element singly. Recognition of this has enabled steels of the required degree of hardenability to be produced with considerable economy in alloying elements and has proved of greatest value during the war in the matter of conservation of strategic alloying elements.

One aspect of the influence of chemical composition which should not be overlooked is the wide variation of hardenability which can be obtained within the limits of a single steel specification. A permitted range of analysis is an essential feature of every specification, and there are also present in most steels small but variable amounts of elements inadvertently picked up during melting, usually referred to as "residuals". These variations in analysis naturally lead to variations in hardenability from cast to cast of what is nominally the same steel.

The opportunity for increased application of the principle will be widened the more the user forgets about the old chemical requirements for any steel and specifies in terms of suitability in terms of quench hardening in a given section. Chemical composition means little or nothing to the engineer who is chiefly concerned with mechanical properties. Specification on a hardenability basis would help to avoid unnecessary waste of alloying elements. In the course of the war it was discovered that the number of different compositions of alloy steel for engineering use had been extravagantly large and a study was made in England by a Technical Advisory Committee which found among other things that for parts requiring steel of 55-65 tons per sq. in. tensile strength, there were in use seven different alloy steels—Mn Mo, C Cr, Cr Mo, 3½ Ni Mo, 3 Ni Cr, 3 Ni Cr Mo and 3 Cr Mo which could have been in most cases satisfactorily replaced by a properly heat treated ordinary carbon manganese steel. The Committee made drastic revision of the specifications and reduced their number from 3,000 to 83 with resultant great economy of material.

Another example where rapid progress has been made with less expenditure of labour and material through being based on a more systematic knowledge of the constitution of metallic systems which we now possess is in the case of permanent magnet steel. The original Japanese (Mishima) steel for permanent magnets was invented as the result of a very lengthy series of trials of alloys of varied composition, probably running into many thousands. Although magnetic theory is still imperfect in comparison with that of other branches of physics, it has made such progress that the latest compositions and heat treatments of permanent-magnet steels, including cooling in a strong magnetic field have given results far transcending those of the Japanese workers, without the long and laborious process of trial and error. The constitution of these complex steels has been revealed and has proved useful guides to composition and heat-treatment.

The original Mishima magnet was an alloy containing 29 per cent. nickel and 13½ per cent. aluminium. These were further improved by the addition of cobalt. These alloys, in contrast to the earlier carbon and tungsten steels, were hardened by a precipitation process without the use of carbon as an essential hardening element. The British Alnico permanent magnet was the next development which contained copper in addition to iron, nickel, aluminium and cobalt and it was soon found that these alloys when cooled from a high temperature in a strong magnetic field gave remarkable results with an increase in energy content to approximately double that of the best alloys that were formerly available. Magnets treated in this way are anisotropic and in directions at right angles to the originally applied field there is slight reduction in the properties.

Alnico magnets present no difficulty to casting operations if the final product is to be of large, regular size. But the product is mechanically weak, because of large grain size and is difficult to machine into small parts

or those of intricate shape. These small magnets are now made by the "powder metallurgy" technique since they can be moulded of powders directly to size and shape and their dimensions held within commercially accepted tolerances during subsequent sintering. The magnetic properties of the sintered magnets are comparable with those obtained by casting technique and their grain size is very considerably finer. As a result the magnetic flux distribution in the sintered magnet is relatively more uniform and its mechanical strength is several times that of the cast alnico. This "powder metallurgy" has recently become an important part of industry. Among other developments the production of porous masses having good mechanical strength but being able to absorb and retain oil so providing self-lubricating bearings may be mentioned. Such objects as gears may be made to exact shape by moulding thus avoiding the labour and cost of machining from a solid block. A further very important class of materials prepared by this method is that of the "hard alloys" consisting of metallic carbides bound into a compact mass by metallic particles and used as cutting tools.

For permanent magnets the internal strain and non-homogeneity in the steel have to be kept as high as possible in order that the material may not be readily demagnetized. Now, it has been found by X-ray methods that these large internal strains are introduced in the iron nickel aluminium alloys by a segregation on an atomic scale which takes place on the parent lattice when the alloys are cooled from a high temperature due to breaking up of the original structure into two phases having different lattice parameters. The extent of the segregation is controlled by varying the rate of cooling and it has been found that the optimum properties are obtained only by a definite rate of cooling so that complete separation into two phases does not occur.

The heat treatment given to these anisotropic alloys consists in cooling at a controlled rate from about 1,200° C to 600° C in the presence of a magnetic field. By this treatment the internal strains resulting from precipitation hardening and also from magnetostriction both tend to maintain the magnetization in a particular direction, *i.e.*, the direction of the originally applied field. The energy content of the permanent magnets now available commercially is more than ten times greater than that of the old 6 per cent. tungsten steels and in addition they possess a high resistance to loss of magnetization due to repeated impacts, alternating magnetic fields and exposure to elevated temperature.

Interesting as the results have been in the development of permanent magnet steels, equally important developments have taken place in the field of high permeability materials. The marvellous impetus arising out of the inventive genius of Ampere and Faraday would have been greatly hampered had not metallurgists placed at the disposal of electricians silicon-iron sheets of low hysteresis and high resistivity, without which the cool running of high-power dynamos and alternators would have been impossible and the efficiency of these machines extremely low. High voltages require to be transformed up and down by several steps; hence the efficiency of transformers becomes a question of primary importance. By regulating composition and rolling and thermal treatment it has been possible in a very few years to cut down cyclic losses and reduce the same in the proportion of 3 to 1.

The present manufacture of transformer sheet is carried out using a steel melting procedure which reduces impurities such as carbon, oxygen and sulphur to a minimum. The sheet, after rolling, is subsequently heat-treated

to give a large grain size and to have very low residual stresses. The presence of 3 to 4 per cent. silicon enables the oxygen content to be kept low and it also gives a material with higher electrical resistance than pure iron which leads to a reduction in eddy current loss.

Whilst in permanent magnets the strain and non-homogeneity must be kept as high as possible, the essential requirement for high permeability material is the elimination of internal strain. The presence of foreign atoms such as carbon, sulphur, etc. particularly when segregated on the iron lattice leads to local regions of strain and prevents easy magnetization. Stresses set up by plastic deformation or by precipitation phenomenon have also an adverse effect on permeability. Further, large grainsize material is preferable because the lattice distortion which is anticipated at the grain boundaries of a sheet having different crystallographic orientation may affect adversely on the magnetic properties.

In single crystals, the magnetization depends upon the orientation of the crystal relative to the direction of the magnetic field. The crystallographically equivalent directions in which saturation is attained with the lowest field are known as the easy directions of magnetization. On single crystals of iron it has been found that the easy direction of magnetization is along the cube edge of the crystal. By suitable cold rolling and annealing treatment preferred orientation can be set up in polycrystalline sheets whereby the majority of the grains are oriented so that the cube edge lies in the direction of rolling. Such material behaves approximately like a single crystal and if magnetization is directed along the rolling direction, it gives a substantial improvement in performance over normal polycrystalline material. This principle is now being applied to the 3 per cent. silicon iron alloys.

For special purposes where very high permeabilities at low field strengths are required alloys of the iron nickel type are used. Here too improved properties are obtained by utilization of the preferred orientation produced by careful rolling technique and by thorough annealing often at high temperatures in an atmosphere of hydrogen presumably to reduce the impurities.

Like the permanent magnets additional improvements have been achieved by cooling the iron nickel alloys from the heat treatment temperature in a magnetic field. The elastic stresses which are set up due to the change in volume on magnetization occurring owing to magnetostriction are probably relieved by slow cooling in a magnetic field and thus account for the improved magnetic properties. On materials containing about 70 per cent. nickel, the maximum permeability is increased by a factor of from 10 to 80 times when tested in the direction of the originally applied field. It must be remembered, however, that the enhanced magnetic properties obtained as a result of preferred orientation or by cooling in a magnetic field are directional and as in the case of permanent magnets already mentioned, the resulting material is anisotropic and in directions other than the preferred direction the properties are inferior.

Within the field of steel metallurgy the development within recent times which has most widely appealed to ordinary laymen has been that of stainless steel. The benefits of this development have been extremely widespread and indeed have reached almost every modern household in the form of stainless steel cutlery. The industrial and engineering uses of this new series of steels are probably of even greater value to the modern economy although they are less well appreciated publicly.

The discovery of stainless steel is a well-known story. In 1913 Harry Brearly of Sheffield was experimenting with alloy steels for gun barrels and among the samples which he threw aside as being unsuitable was one containing about 14 per cent. chromium. Some months later he saw the pile of scrap test pieces and noticed that most of the steels had rusted but the chromium steel was still bright. This led to the development of stainless steels as typified by our present day cutlery. At first there was just this 'stainless steel' a relatively simple alloy containing about 12 to 14 per cent chromium and 0.3 to 0.35 per cent. carbon with iron as the major constituent and much smaller proportions of silicon and manganese. Since then the so-called stainless steels, which really should be designated as corrosion-resistant steels have multiplied, until the designer and engineer today have at their disposal a whole range of complex materials intended both to provide varying degrees of hardness and to meet the innumerable forms of corrosive attack.

The materials now available can be classified under 3 general headings:

1. Plain chromium steels (12-20 per cent. chromium) with different carbon content.
2. High chromium low nickel steels (16-20 per cent. chromium with 2 per cent. nickel.)
3. Austenitic chromium nickel steels with or without additions of special elements such as tungsten, titanium, columbium, molybdenum and copper.

The essential steel under Group (1) contains about 13 per cent. chromium with 0.3 per cent. carbon and was the original steel as used for stainless cutlery. For optimum corrosion-resistance it is necessary that the steel should be put into a hard condition and, of course, a knife demands a hard condition to give suitable cutting properties. When engineers realised the corrosion resisting properties obtainable from this steel they naturally thought of the possibility of a stainless steel which would be equally rustless and acid-resistant but which would be sufficiently soft and ductile to permit fabrication into items of chemical and engineering plant.

The first step in this direction was to reduce the carbon content of the steel to something of the order of 0.1 per cent. This resulted in a steel which was softer and which had an appreciable degree of ductility, at the same time having a corrosion resistance in its soft condition of a similar order to that of the hardened stainless knife. The low carbon stainless thus produced is often referred to as stainless iron.

The steel in Group (2) is of the hardening type and is usually put into service with a tensile strength of the order of 50-65 tons per sq. in. It will be noted that this steel contains a somewhat higher chromium content than the cutlery stainless steel and the stainless iron referred to earlier. In addition, approximately 2 per cent. of nickel is added with the result that in the 55-65 tons per sq. in. tensile condition this material possesses corrosion properties intermediate between the plain chromium steels already discussed and the austenitic steels to which I will now refer.

Coming now to steels in Group (3) these are all essentially austenitic by virtue of their higher alloy content. The corrosion-resistance of this group of steels is the highest obtainable and at the same time these steels have the maximum degree of ductility and lend themselves most readily to fabrication into chemical plant.

These materials depend for their corrosion-resistance on thin surface oxide films generally formed by exposure to air. Although such films exist on mild steel and low alloy steels, they are readily penetrated by corrosive agencies. The high percentage of chromium in the steel is responsible for giving a very much stronger protective film. This is generally referred to as the passive film and it will be interesting to know that this film can actually be separated and observed. A remarkable feature of this film is that if the surface of the steel is scratched, the corrosion resistence is not destroyed, as spontaneous self- healing of the film takes place. The addition of nickel, molybdenum and other elements modifies the corrosion-resistance and we deduce that these elements assist in producing a modified protective film.

The formation of an oxidized film, highly protective against chemical attack, was an old experience of workers in steel, the colour of the film varying with its thickness, and being used as a means of determining the temperature to which the steel had been heated. The film which is the cause of passivity is regarded as being of the same nature, but as too thin to show colour. A strong film may be isolated either by dissolving away the metal as in the case of iron or by removing the metal as a volatile compound as in aluminium.

When the layer of oxygen on the surface is too thin to form a film with a definite refractive index, it may yet be protective, and may be detected by other means than optical measurements. X-rays even at glancing incidence penetrate too deeply but beams of electrons reveal a structure. As a means of studying structure, the electron beam method resembles the use of X-rays of exceedingly short wave length although caution must be used in the interpretation of the patterns on account of the different degrees of interaction with atoms. The penetrating power of electrons is, however, very small compared with that of X-rays and this makes the method particularly valuable in the study of thin films and of surface structures. It has been shown for instance, by the electron diffraction experiments that whilst most oxide films on solid metals are crystalline, the highly protective character of the thin film formed on aluminium and some of its alloys at low temperatures is associated with its amorphous character.

The discovery and development of the chrome-nickel austenitic class of steel had an enormous influence on chemical industry. Welding is used to a great extent in the fabrication of such equipment and the very serious troubles which were encountered at the initial stages were due to the phenomenon of "weld decay." It was found that under certain conditions the material in the immediate vicinity of the weld was subject to a virulent type of intercrystalline corrosion. On cooling from the welding temperature, the small content of residual carbon in the steel was precipitated at the grain boundaries and formed chromium carbide. This led to a local impoverishment in chromium and prevented a satisfactory protective film being formed. Under these conditions, rapid corrosion could occur at grain boundaries leading to a speedy disintegration of the steel. Once this mechanism had been discovered, a cure was rapidly introduced, namely, close control of the carbon-content and addition of elements such as titanium and niobium which have a greater affinity for carbon than chromium.

While considerable progress has been made with the more highly alloyed types of steel as mentioned above which possess a very high degree of resistance to corrosion, the study of the effect of small alloy additions upon the rate of corrosion of iron has not been promising in that no great

improvement has been obtained with small additions of alloying elements. The object governing the manufacture of these steels has been to obtain at not too high an increased cost a steel capable of resisting, not indefinitely but longer than ordinary steel, the action of the air in the atmosphere of a works or the corroding action of water, chiefly sea water. The use of very pure iron alone or with the addition of a proportion of copper or molybdenum has given interesting results in particular instances. A steel with 0.5 per cent. copper and 1 per cent. of chromium is reported as being 50 per cent. better than mild steel and roughly the same result is obtained with 3 per cent. nickel. Lack of success in this direction has led to an extensive study of protection by paints, etc., and an improved practice has been established where the importance of proper surface preparation and the use of efficient inhibitive priming paints are stressed. This has been made possible from the very important contributions to our knowledge of the fundamentals of the subject of corrosion which have been made as a result of a continuous attack on this problem during the last 20 years. Laboratory studies on atmospheric corrosion with particular reference to the formation and breakdown of primary oxide films and the effects of impurities, including solid particles and relative humidity as well as extended field study of the corrosion of iron and steel have also been of great importance.

Metallurgy has been busy of late years in the study of steels which show satisfactory resistance both to mechanical stresses and to oxidation at high temperatures. Research on these lines is most interesting, particularly with reference to internal combustion engines whose efficiency rises with the temperature of the cycle. At present the available types of alloy include a number of different groups rather similar to the groupings of corrosion resistant alloys. The question of the most suitable material for any application depends on whether resistance to scaling is required or whether maintenance of strength at high temperature is the dominant factor. They are as follows:

(1) Silicon-chromium steels.

(2) Plain chromium steels (12 30 per cent. chromium).

(3) Austenitic chromium nickel steels with or without additions of tungsten, molybdenum, titanium and other elements.

(4) Higher nickel chromium alloys such as alloys containing 60 per cent or more of nickel and the balance largely chromium.

The silicon chromium steels in Group (1) possess good resistance to oxide and are used essentially for the manufacture of internal combustion engine exhaust valves. In this steel the chromium does much towards providing resistance to scaling and is reinforced by the high silicon content. Steels in Group (2) that is, the plain chromium steels are useful for resisting scaling at elevated temperatures but such steels have no appreciable strength at high temperatures. The austenitic chromium nickel steels containing other special elements in Group (3) have amazing properties. For example, a steel is available today which is satisfactory as regards resistance to scaling and which at a red heat, has a fatigue strength of a similar order to its fatigue strength at normal temperatures and exceeding the fatigue strength of mild steel at ordinary temperature. This makes possible the production of apparatus which is capable of working under high stresses in a range of temperature that has hitherto not been possible.

Fundamental work on the mechanism of the oxidation of metals at high temperature and the growth of such oxide films has provided a satisfactory background to the industrial research into the development of these alloys. If we consider the oxidation of metals exposed to air we find that the heavy metals do not readily burn in air, and yield oxidation curves which definitely fall off with time; this is not surprising since the oxide, if unconstrained, would occupy a larger volume than the metal destroyed in producing it and is thus likely to be obstructive. There is, especially at high temperature, a law of growth of thick oxide films according to which the thickness of the film increases as the square root of the time. This parabolic law, however, does not apply to thin films and moderate temperatures where a law of logarithmic type is more usually found. It has been suggested that when a metal with a thin oxide layer is exposed to air, a constant voltage is set up across the layer and that growth is usually due to the migration of metal ions through it. The rate of migration is in certain circumstances strongly dependent on the field, so that, oxidation practically ceases at a certain thickness.

One aspect of heat resisting steels which has been of great practical importance in the engineering demand for materials to withstand high stresses at elevated temperature is that of the phenomenon of "creep." Creep is the slow continuous permanent yielding, under steady load and is characteristic of metals at temperatures above their recrystallisation temperature and is accordingly significant in most engineering metals, at relatively high temperatures. If a tensile test is pulled in the normal manner at elevated temperature, the material yields at a certain stress and ultimately breaks at a higher stress. On the other hand if a considerably lower stress than that required to cause the steel to yield under normal conditions of test at high temperature be applied for a long period of time the material will still elongate or "creep." This phenomenon of creep comes into play at temperatures around 400° C. and upwards and at temperatures of the order of 600°—800° C the question of creep may become very serious.

If a tensile test were made at 500° C on an ordinary mild carbon steel having at room temperature a maximum stress of say, 30 tons per sq. in. and a 0.05 per cent. proof stress of about 17 tons per sq. in., these values would probably be about 20 tons per sq. in. and 8 tons per sq. in. respectively. But the deformation at 8 tons per sq. in. would not stop during the course of the test and if the test were prolonged the rate of deformation would still be of the order of 0.001 per cent. per hour at 100 hours and would probably not have decreased very much at 1,000 hours. It is often found that the rate of creep increases with time instead of remaining constant or decreasing and failure may occur at a much earlier time than would be expected. If we consider the case of still higher temperatures, say 1,000° C and the use of heat resisting steels where oxidation would not be an important factor leading to premature failure, then in the normal tensile test the maximum stress would be of the order of 5 tons per sq. in. but the permissible stress over a period of years would only be a few hundred pounds per square inch, since the creep would be very considerable at higher stresses.

It will be clear from the above examples that in order to assess the suitability of a material for service at elevated temperatures not only has the time factor to be considered but also the amount of permissible deformation in service life has to be estimated before a safe stress can be determined. In recent years a large amount of work has been carried out on the determination of the "limiting creep stress" of materials at different temperatures, this

being the stress at which the deformation in a given period of time will not exceed a given (very small) amount the definition of limiting creep stress thus being more or less arbitrary. The periods usually lie between 1,000 and 100,000 hours and the permissible deformation is usually 1 per cent. or less. Thus to properly study the different rates of creep under various stresses at different temperatures is a lengthy procedure.

Many attempts have been made to deduce creep properties from other properties which can be determined by relatively rapid tests or from creep tests in which the time of testing is greatly reduced by using higher loads. Hatfield's "Time-Yield" method of assessing the creep characteristics of materials in a relatively short time has been found to form a very useful basis for rapid comparison. The "Time Yield" stress is approximately equivalent to a rate of creep of 1|1,000,000 inch per inch per hour. A specimen submitted to the "Time Yield" stress for the temperature in question should not show an extension exceeding 0.5 per cent. of the gauge length in the first 24 hours, and during the next 48 hours should show an extension not greater than 1|1,000,000 inch per inch per hour.

The study of creep resisting materials of low alloy type has received a very considerable stimulus from the tendency for steam plant in power stations to work at high temperatures and pressures; and during the war years the development of the gas turbine for jet propulsion has given a similar incentive for the study of high alloys of the heat resisting types. Ordinary mild steel usually gives excellent service in suitably designed components in the range of temperatures up to about 400° C. With the increase in the size of plant larger forgings have been called for and it has been necessary to use alloy additions such as nickel, chromium and molybdenum to obtain improved mechanical properties suitable for the higher operating stresses at normal temperatures. These steels are also more resistant to creep than are carbon steels. At higher temperatures the composition requires to be such that resistance to oxidation is sufficient for the service conditions and it has been found advantageous as already explained, to work with austenitic alloys of the 18 per cent. chromium 8 per cent. nickel type. The original 18-8 steels are better in resistance to creep than are mild steel or even the low alloy types at temperatures of the order of 500° C, and upwards, but additional improvements were obtained by the addition of small quantities of special elements such as tungsten, molybdenum, titanium and niobium. These elements form compounds with carbon and a part at least of the carbides so formed can be dissolved in the austenite at high temperatures and slowly precipitated subsequuently at temperatuures of the order of 700° C.

The importance of the use of metals of high melting point and the effectiveness of alloying as a means of improving the creep strength has been stressed in the metallurgical control of creep. Grain coarsening though generally exerting a favourable influence on creep strength is undesirable in other respects and is avoided if possible. The most useful expedients in practice are the addition of alloying elements which raise the softening temperature, the judicious use of precipitation hardening effects and, in the appropriate temperature range, of a carefully controlled degree of work hardening. The relation between precipitation hardening and increase of creep resistance has been shown to be complex but a close relation exists between the form of the solid solubility curve and the composition of the precipitation hardening alloy which gives the most favourable results at a given temperature of service. The creep resistance of many alloys is affected

profoundly by small additions made during the oxidation process. In these cases there appears to be little relation between the metallographic structure and the creep resistanc, and the explanation of the phenomena is still uncertain. Co-operative research work has recently been started in England in order to study, by means of X-rays, the change in lattice structure during the progress of creep and other associated phenomena, such as creep recovery and relaxation and it is hoped by this means to throw more light on the fundamental causes of creep.

This brings me to the application of X-ray diffraction methods to the study of metallurgical problems. In X-ray photographs of metals, the lines produced by each element, or phase, are characteristic, and their general pattern enables the crystalline structure to be identified; the scale of the pattern can be used to determine accurately the size of the unit cell and therefore the distance apart of the individual atoms; and from the relative intensity of the lines can be deduced the distribution throughout the unit cell of the various types of atoms in an alloy, or in other cases the degree of preferred orientation in the material. In addition the sharpness of the lines provides information on both the state of strains and the grain size of the material.

The technique of X-ray crystallography and its industrial application have expanded considerably in the past 15 years and have provided important fundamental information about metals. The sizes and arrangement of the atoms are known; from such information it is possible to deduce which elements will take their place in the lattice of the solvent metal and which will be accommodated in the interstices, a matter of great importance in determining the properties of an alloy. X-ray methods also indicate limits of solid solubility, fixed mainly by geometrical considerations and recent work has shown how the first segregation of foreign atoms occurs in the varied series of changes known as age hardening.

The theory of metals, involving problems of extreme mathematical difficulty, is progressing rapidly. The application of wave mechanics to the physics of metals and the recently acquired knowledge of the crystalline structure of alloys have enabled many of the peculiar properties of alloy systems to be correlated—a particularly outstanding achievement being the quantum derivation of the Hume-Rothery rule governing the electron: atom ratio for the phase boundaries in certain alloy systems.

Physicists tell us that the true fracture strength of a metal is theoretically at least ten times as large as the observed overall fracture strength. If metallic masess consisted of perfect crystals the problem of predicting their mechanical strength would not be difficult; but they are not perfect. Crystals have an internal mosaic structure and it has been suggested that the observed mechanical properties are governed by the presence of minute dislocations or flaws which can be displaced during a change of form. A knowledge of the space lattice and of the electrical condition of the metallic atoms is not enough for predicting the cohesive properties of a metal in mass and we have to be content with empirical results.

Metallurgy is not a fundamental science. In so far as it is a science at all, it consists in the study of physics and chemistry as applied to the special class of metallic substances. It existed as an art thousands of years before

it was furnished with a scientific basis, and in some branches skill and empirical knowledge still outweigh scientific understanding. It is at an exciting stage of development in which broad generalisations like those existing in the older sciences had not yet emerged. The field is ripe for great advances in the formulation of general principles, for a wealth of uncorrelated experimental material exists. As theoretical knowledge increases it will lead application and not, as in the past, follow it. We can look forward to a period in which the nature, structure and behaviour of metals are so well understood that alloys can be designed with certainty for new applications with little development work. Simultaneously, possibilities are attractive for getting better service from present alloys as their nature and treatment are understood and stopping the wastage of our limited natural resources by proper utilization of alloying elements.

SECTION OF AGRICULTURAL SCIENCES

PRESIDENT: RAI BAHADUR KALIDAS SAWHNEY, M.Sc., F.A.Sc.

URGENT AGRICULTURAL PROBLEMS OF INDIA AFTER PARTITION.

(Delivered on January 3, 1948)

INTRODUCTION

It is my foremost duty to offer you my sincere gratitude for the honour you have conferred on me by inviting me to preside over the deliberations of the Agricultural Section of the Indian Science Congress. The honour is all the greater because this is our first meeting after the Country gained independence on 15th August 1947. I am conscious of my limitations but I hope that I will receive full cooperation from you in making our deliberations a success.

It has been more or less customary for the President of this Section to give in his address an account of his own researches, or to describe the progress of research in the subject in which he is most interested. In view of the momentous and stirring times through which we are passing and the many pressing agricultural problems that have arisen in the wake of the partition of the Country, I propose to depart from the usual practice. Accordingly I have elected to speak on the urgent agricultural problems of India after partition. It is not implied that all the problems enumerated hereafter are absolutely new. Some of them are such as have existed since long, but have become accentuated as a result of the partition of the country. There are others that are fresh problems arising from what has happened after the independence day.

PREDOMINANT FEATURES OF INDIAN AGRICULTURE

Arable farming has been the predominant feature of Indian agriculture since times immemorial. Food crops cover the largest acreage, followed by cash crops of diverse kinds in a rotation which is usually of short duration. Dairy farming and cattle fattening are practically of no importance. All-grass farming is almost unknown. Even the growing of purely fodder crops in the rotation is uncommon in a large part of the country. The production of food for human beings is the principal occupation of the average farmer. Agricultural cattle are usually fed on plant stalks of cereal crops primarily grown for grain. The rotation crops include cotton, groundnut, other oil seed and fibre crops, sugarcane, tobacco, etc. etc. Fruit and vegetble cultivation, more particularly the latter, are practised on relatively small holdings in the vicinty of towns and large villages. Poultry farming and dairying do not exist as organised industries. Every peasant or agricultural labourer, and often times non-agricultural villager too, keeps a few low quality birds to which no particular attention is devoted. Similarly, a few heads of dairy cattle are maintained by every farmer who can afford. In and around

cities, milk production is in the hands of a particular class of people, known as *gowalas.* But even here the number of milch animals maintained by each family seldom exceeds half-a-dozen. Good breeds of draft cattle are available in different parts of the country, but the cattle of the average cultivator are usually of a mixed breed and miserable physique.

The vast bulk of the area under cultivation depends on a highly uncertain rainfall for the growing of crops. The area of irrigated cultivation in the Dominion of India represents only about 20 per cent of the net area sown.

Except in irrigated tracts and those parts of the country where pressure of population is great and holdings are relatively small, the preparation of soil for sowing is hurried and unsatisfactory, manuring inadequate, and interculture, not what it should be. The seed used is a mixture of types and, on the whole, low yielding. Selection of good seed is practised by few. The improved seed developed by the Government Agriculture Departments covers only a small area except in the case of cotton and sugarcane. Insect pests and plant diseases are usually uncontrolled and the annual loss caused by them both in the field and store-houses is colossal. The average cultivator is more or less illiterate and steeped in poverty and destitution. He has neither the knowledge of scientific methods of cultivation, nor the means to put it into practice. His cultural practices as mentioned already are not really conducive to good yields. The net result of all these factors is that the average yields per acre of most of the crops in a greater part of the Dominion are low and compare very unfavourably with those of the agriculturally advanced countries. The cash income per family is small, the standard of living of the average family farmer is low, and the rural areas in large parts of the country still need proper development. In the course of his address as President of the Agricultural Section of the Indian Science Congress in 1945, Professor Joshi said that "the description given of the agriculturist as illiterate, ignorant, indebted and poor in 1890 still holds good." This may be a slightly exaggerated view, but unfortunately much of it is too true to be disputed.

DURING THE GREAT WAR AND IMMEDIATELY AFTER

During normal times the indigenous production together with variable but easily obtained imports of food meet the ordinary requirements of the population. No one gives much thought to the agricultural producer or the methods employed by him. It is only a great war or an equally devastating other upheaval that brings home to the public and the government the national importance of agriculture. Before the recent great War, it was more or less the general policy of the Government of India as well as the Provincial and State Governments to dole out only small funds for agricultural research and development work. During the War, the shortage of food, created by the cessation of imports from abroad, made the governments awake to the importance of increased food production within the country. It is around this pivot that plans and schemes were prepared and hurriedly brought into existence for increasing the area under food crops, restricting the growing of cash crops, expanding production and distribution of manures, supplying large quantities of pure seed of improved varieties, subsidising the sinking of irrigation wells, increasing production of vegetables and fruits, raising crop yields by contour bunding and dry farming, and bringing culturable waste land under the plough. The control of prices, procurement of buffer stocks of food by government, and individual

rationing in large cities and bulk rationing in rural areas were put into operation for the equitable distribution of production. All this has involved planning of production, procurement and distribution. It has brought into prominence the part that agriculture plays in the economy of the country. Finally, the declaration of the United Nations' Conference on Food and Agriculture, recommending the improvement of nutritional level and the standard of living of each nation brought to the forefront the problem of agricultural development. The relevant portion of this declaration reads as follows:—

"This Conference, meeting in the midst of the greatest war ever waged, and in full confidence of victory, has considered the world problems of food and agriculture and declares its belief that the goal of freedom from want of food suitable and adequate for the health and strength of all people can be achieved.

(*a*) The first task is to complete the winning of the War and to deliver millions of people from tyranny and from hunger. During the period of critical shortage in the aftermath of war, freedom from hunger can be achieved only by urgent and concerted efforts to economise consumption, to increase supplies and distribute them to the best advantage.

(*b*) Thereafter we must equally concert our efforts to win and maintain freedom from want. The one cannot be achieved without the other.

(*c*) There has never been enough food for the health of all people. This is justified neither by ignorance nor by harshness of nature. Production of food must be greatly expanded; we now have knoweldge of the means by which this can be done. It requires imagination and firm will on the part of each government and the people to make use of that knowledge.

(*d*) The first cause of hunger and malnutrition is poverty. It is useless to produce more food unless men and nations provide the markets to absorb it. There must be an expansion of the whole world economy to provide the purchasing power sufficient to maintain an adequate diet for all. With full employment in all countries, enlarged industrial production, the absence of exploitation, an increasing flow of trade within and between countries, an orderly management of domestic and international investment and currencies, and sustained internal and international economic equilibrium, the food which is produced can be made available to all people.

(*e*) The primary responsibility lies with each nation, for seeing that its own people have the food needed for life and health; steps to this end are for national determination. But each nation can fully achieve its goal only if all work together."

The United Nations Conference recommended that Governments and authorities should recognise the obligation to their respective people and to one another, henceforth to collaborate in raising levels of nutrition and standards of living of their people. It also made many recommendations in the field of production, distribution and consumption of food and other agricultural products and expressed the opinion that the successful carrying out

of these recommendations in the post-war period will be the most important pre-requisite for the achievement of freedom from want.

In 1944, in discussing India's average annual production of principal foods, the Advisory Board of the Imperial Council of Agricultural Research in its Memorandum on the Development of Agriculture and Animal Husbandry in India stated that the production is inadequate to provide the nutrition expert's requirements for a suitably balanced diet in minimum quantity for the 400 million people in India. According to the Advisory Board, to meet these requirements in full, the production of the various articles of food for men and cattle must be increased as follows:—

Cereals	by 10 per cent.
Pulses	by 20 per cent.
Fats and oils	by 250 per cent.
Fruits	by 50 per cent.
Vegetables	by 100 per cent.
Milk	by 300 per cent.
Fish and eggs	by 300 per cent.
Oilcakes and other concentrates ..	by 400 per cent.
Fodder	by 55 per cent.

These increases would need to be of a still higher order, if the increase in population and the rising standard of living are also taken into consideration. These estimates indicate prominently the precarious position of the country in respect of its food requirements. The production of non-food crops like cotton, castor, tobacco, jute, groundnuts and the like was curtailed and special measures mentioned already were adopted by Provincial, State and the Central Governments in furtherence of their campaigns for the growing of more food. However, due to a failure of rains in two successive years in many parts of the country, the indigenous production of food fell a good deal short of the actual requirements. This caused much misery, and in Bengal hundreds of thousands of people died of starvation. The conditions after the War did not show much improvement. Not only the lag between the production and consumption of food has continued, but also the general farming conditions have remained unameliorated. In 1946, a severe attack of 'rust' caused a virtual destruction of wheat crop in the southern and central parts of the country, causing a loss of about one million tons of grain. Had it not been for large imports of food grains from abroad, many parts of India would have suffered from acute famine during the past two years.

Realising the unsatisfactory state of argiculture and animal husbandry, almost all the Provincial and many State Governments prepared comprehensive plans for development after the War, and in some instances. made budgetary provision to be used later for this improvement work. Ambitious schemes were drafted and preparations were set afoot for the training of the technical personnel and the purchase of equipment and machinery needed to get the schemes going.

YEAR 1947.

The year that has just ended has been a period of extraordinary rush, unforeseen developments and startling happenings. It has seen revolutionary

political changes, followed by exchange of population on a tremendous scale in some parts of the country. It would have been unnatural if the country had been completely free from the untoward results of cataclysmic changes that have taken place in the political make up of the country following so rapidly in the wake of a protracted and catastrophic world war. Before the country has had time to recover from the effects of the war, it has been partitioned into two independent States. The division of the country has been followed by an inter-communal conflict in the north-west, necessitating the uprooting of millions of persons from their ancestoral hearths and homes and planting them in strange surroundings. These happenings have accentuated certain already existing difficulties and raised certain other fresh problems. They have also upset the development plans which the Central and Provincial Governments had prepared and the fruition of which the people had so fondly looked to. These new problems arise from three sources, namely, the partition of the country, the destruction caused in the inter-communal conflicts, and the unforeseen large scale exchange of populations. I will confine myself to agricultural problems.

As a result of the partition of the country, the irrigated food-producing tracts of West Punjab and Sind have been allotted to Pakistan. These are surplus areas and in the past they used to meet the wheat and rice needs of some of the deficit Provinces of undivided India. This exclusion of these fertile irrigated tracts has accentuated the food difficulties of the Dominion of India. The internal production of wheat and rice has to be stepped up a great deal, and in the meantime alternative foreign sources of supply have to be tapped. Fortunately the deficit is estimated to be of the order of 3 to 6 per cent. only. With proper planning, increased use of manure, and provision of greater irrigation facilities, it is possible to make up this deficit even from our existing cultivated area. The Bhakra Dam in East Punjab, the work on which is to be started almost immediately, will provide water for nearly 4 million acres in Hissar, Rohtak and the adjoining areas. The Damodar Valley Scheme, recently sanctioned by the Government of India, will provide irrigation water for vast areas in West Bengal. Similarly the other projects under consideration will further increase the irrigated acreage.

The irrigated tracts of Sind and West Punjab also produce large quantities of long staple cotton. The effect of the division of India on the production and consumption of long and short staple cotton is shown in the following statements:

* 1. Estimated Production in lakhs of Bales of 400 lbs. net.

	Dominion of India (excluding States).	Dominion of Pakistan (including Bahawalpur and Khairpur).	Other Indian States.	Total.
(a) Long and Medium staple ..	10.37	13.82	2.75	26.94
(b) Short staple	4.59	2.88	7.03	14.50
Total ..	14.96	16.70	9.78	41.44

2. Estimated Mill Consumption in lakhs of Bales of 400 lbs. net.

	Dominion of India.	Indian States.	
(a) Long and Medium Staple ..	18.00	2.88	20.88
(b) Short staple	7.00	3.12	10.12
Total ..	25.00	6.00	31.00

* Through the courtesy of the Indian Central Cotton Committee.

The extra factory consumption of cotton in the Dominion of India is estimated to be 2.7 lakhs of bales. Thus the total deficit in the supply of cotton for the Indian Dominion works out to 8.96 lakhs of bales. To meet this deficit, the existing acreage of cotton in the Indian Dominion will have to be raised by nearly 33 per cent, the increase being largely under long and medium staple types which are urgently needed by the textile mills located in the Dominion. If provision has to be made for an annual export of about 4 lakhs of bales, then the deficit will amount to 12.96 lakhs of bales, and the cotton area will have to be increased by about 50 per cent. The deficit can partly be met also by the greater use of improved seed and manures, and the provision of increased irrigation facilities.

The partition of Bengal and the allocation of its eastern part to Pakistan has left the Indian Dominion with only 30 percent of the annual production of jute before partition. As against this, the jute manufacturing industry remains almost wholly with the Indian Dominion. Jute production has, therefore, to be increased not only to meet home requirements but also to feed factories manufacturing jute goods for export. The expansion of jute production will have to be effected largely by the use of better seed and improved cultivation methods because there is not much scope for the enlargement of its area. For climatic reasons, jute cultivation is confined largely to Bengal, Bihar and some parts of Assam and Orissa, and even in these Provinces, the area under the crop cannot be increased much except at the cost of food crops. A development of this kind is not advisable, these Provinces being deficit in food production.

The communal disturbances have fortunately not caused any serious destruction of the means of agricultural production. Killings in the countryside left the standing crops unharvested in some cases, but this by itself has not produced any long range problem. The same cannot be said unfortunately of the large scale transfer of population that followed the communal conflict. The migration of over 4 millions of people from western Pakistan into the Indian Dominion has created the vast problems of relief and rehabilitation in East Punjab and the adjoining Dominion and State territories. A large majority of the refugees hails from rural areas and belongs to the cultivating class. Most of such refugees are either peasant proprietors or are agricultural labourers. Many of them are skilled farmers who were once the proud owners of prosperous farms in the canal irrigated colonies of the central and western districts of the undivided Punjab. The area abandoned by them in their ancestoral homes in western Pakistan is estimated to total 5.7 million acres. The corresponding area left by the emigre's from East Punjab is only 4.5 million acres, and of this, no more than 3.3 million acres is said to be culturable. The area ultimately available for resettlement of rural refugees may perhaps be only 3 million acres. Furthermore, whereas a good deal of the area abandoned in West Punjab is canal irrigated, that left in East Punjab has a much smaller proportion of irrigated area. Thus

it will be observed that there is not enough land available in the East Punjab to settle these immigrants on economic holdings. Finally, most of these settlers have had to leave even their fluid resources behind and have to start in their new homes from scratch. The provision of adequate financial assistance in the form of subsidy or *taccavi* loans is absolutely necessary. The whole problem of resettlement is so vast and important that it must be given the most urgent consideration.

PLANNING AND COORDINATION OF EFFORT

Our resources of fertile land, agricultural machinery, technical staff and money are limited, whereas our problems of increasing agricultural production, resettling refugees, and raising the cash income of ryots are very vast as well as pressing. Development can brook neither delay nor duplication of effort. It is most essential that the resettlement of refugees is coordinated with the increased production of food and cash crops in a well-considered integrated plan. Every thing must be done to get the best results out of our limited resources. We cannot possibly afford to fritter our energy or the materials at our command.

It is fortunate that the plans for the construction of Bhakra Dam on the upper reaches of the Sutlej river in the East Punjab have reached an advanced stage and the work is to be started soon. The dam will not only provide irrigation water for four millions of acres but also a large amount of electric energy (300,000 K.W.) for both industry and agriculture. The construction of this dam must be completed with all possible speed. The need for developing irrigation and power resources in other parts of the Dominion is equally urgent. Our resources of foreign currencies are being rapidly exhausted by imports of food. Last year nearly 100 crores of rupees were spent in purchases of food grains from abroad, and about 15 crores of rupees were lost by selling the high priced imported grain at the relatively lower internal prices. It is estimated that the total cost of the food imported in the last three years is almost equal to twice the capital cost of all the irrigation works constructed in undivided India. This indicates forcibly that the country cannot afford the huge expenditure on food grain imports for any length of time. All our plans for industrial and social development are also being held up on this account.

PLANS OF SETTLEMENT

In the preparation of plans for increased agricultural production and the solution of the post-partition problem of resettlement of refugees, careful consideration must be given to the method of settlement of population on land. It is necessary to determine whether the refugees should be settled as private land owners on relatively small sized individual holdings, or some other method should be adopted. It is said that the authorities in East Punjab are allotting ten acres of land to each individual farmer, but are encouraging allotment on 'group basis.' Unfortunately, the exact details of the latter system are not available at the present moment. In any case, it is good that an alternative method is receiving attention. It cannot be gainsaid that taken as a whole, the private land owner seems to have failed in his duty to himself as well as the nation. Low yields, poor quality of produce, low wages and a very low standard of living for both agricultural labourer and small farmer are the order of the day. The reasons for this state of affairs are many and fairly well known. I need not reiterate them. This must be admitted, however, that there is something radically wrong with the system that has produced all this misery and destitution. It must also be

conceded that the need to mend or end such a system is urgent. "Maximum production of good quality produce and realisation of optimum prices compatible with the consumers' ability to pay should be aimed at." With the technical means available at present for pushing up production, some kind of centralised farm management under expert supervision will greatly help to achieve this aim.

GUIDING PRINCIPLES

The increasing of agricultural production, or for the matter of that, the resettlement of refugees, cannot be divorced from the industrial, economic, social or political development of the country. The methods adopted in agricultural development must be in harmony with the principles guiding India's industrial and social advancement. With a view to draw up an economic programme for the Indian National Congress, the All India Congress Committee in its meeting held in November 1947 decided to appoint a special committee and adopted the following resolution for its guidance:

"Political independence having been achieved, the Congress must address itself to the next great task, namely, the establishment of real democracy in the country and a society based on social justice and equality. Such a society must provide every man and woman with equality of opportunity and freedom to work for the unfettered development of his or her personality. This can only be realised when democracy extends from political to the social and the economic spheres.

Democracy in the modren age necessitates planned central direction as well as decentralisation of political and economic power, in so far as this is compatible with the safety of the State, with efficient production and the cultural progress of the community as a whole.

The smallest territorial unit should be able to exercise effective control over its corporate life by means of a popular elected Panchayat. In so far as it is possible, national and regional economic self-sufficiency in the [illegible] life should be aimed at.

[illegible] case of industries, which in their nature must be run on a large scale and on a centralised basis, they should belong to the community, and they should be so organised that workers not only become co-sharers in the profits but are also increasingly associated with the management and administration of the industry.

Land, with its mineral resources, and all other means of production as well as distribution and exchange must belong to and be regulated by the community in its own interest.

Our aim should be to evolve a political system which will combine efficiency of administration with individual liberty and an economic structure which will *yield maximum production without the creation of private monopolies and the concentration of wealth* and which will create proper balance between urban and rural economics. Such a social structure can provide an alternative to the acquisitive economy of private capitalism and the regimentation of a totalitarian state." Italics are mine).

These are admirable principles and our plans for the solution of India's agricultural problems should conform to them. They should at the same time be such as are most likely to achieve the objects in view.

PRINCIPAL OBJECTIVES

I have already stated that some of the agricultural problems of India are very old, some have arisen on account of the recent partition of the

country and some others are the result of what happened after the partition. Many of the problems are of country-wide importance, while others are peculiar to particular Provinces or States. Our most pressing and widely operative agricultural problems or objectives may be re-stated as follows:—

(*i*) National as well as regional self-sufficiency in food production;
(*ii*) Achievement of balanced nutrition for all;
(*iii*) Rehabiliation of refugees on sound lines;
(*iv*) Meeting the deficit in the supplies of long-staple cotton and jute;
(*v*) Increasing the cash income of the farmer; and
(*vi*) Reconstruction and improvement of rural areas.

Self-sufficiency in food demands increased production of wheat, rice, millets, other cereals, pulses and potatoes together with some oil-seeds, vegetables and milk. On the other hand, balanced nutrition needs concentration on the production of protective foods, rich in proteins, minerals and vitamines. The production of meat, poultry, milk, eggs, fruits and vegetables will have to be increased immensely if balanced nutrition is to be achieved. Rehabilitation of refugees on sound lines means the adoption of a system or systems which will fulfil the moral basis of the All-India Congress Committee's resolution quoted earlier and simultaneously help to achieve the other objectives. Increased production of long staple cotton and jute requires the intensive application of scientific technique and centralised expert management to field crop farming so that the greater production of these cash crops should not take place at the expense of food crops. Increased cash income implies maximum production per agricultural worker. And finally, rural development involves alround betterment of the man behind the plough, his group life and his surroundings.

GROUP CULTIVATION

For the quick expansion of production and the early solution of our other agricultural problems, the choice lies between the primitive methods and limited resources of the small peasant proprietors and group agriculture employing modern methods with centralised farm management under expert supervision. As pointed out already, the small private landowner in India seems to have been a failure at least in field-crop production. He has neither succeeded in meeting the country's food requirements fully, nor has he been able to increase his own income and improve his standard of living in any marked manner. Despite special Government assistance given during the War, he has failed to make much headway. With his existing illiteracy, poverty, inertia and general lack of ambition, not much can be expected from him in agricultural improvement and the urgently needed expansion of production. Organised agriculture on a group basis seems to be the only feasible alternative. There are many different systems of group cultivation in vogue in different parts of the world. Some of the principal ones may be enumerated thus:

(*i*) Consolidated managed farming,
(*ii*) Cooperative farming,
(*iii*) Collective farming,

(*iv*) State farming, and
(*v*) Joint-stock Company farming.

In consolidated managed farming, the land continues to remain the property of individual owners, and the farmers merely agree to joint management. It may be on the basis of a whole village, or a group of a few cultivators growing the same crop or crops. Cooperative farming implies greater coordination and mutual assistance, but here also the land and other ordinary means of production continue to remain the property of individual farmers. Joint purchase of seed and manures, common ownership and operation of costly machinery and equipment, cooperative control of insect pests and diseases, and pooled processing, grading and marketing of produce are the principal futures of cooperative farming. In collective farming, as practised in Russia, the land and all the means of production are the property of the commune. The collective farm is managed as a single business unit. Every collective farmer is required to contribute his own and his family's labour. The minimum work to be done per labourer per day is prescribed and records of labour units per family are maintained systematically. The final net earnings are distributed on the basis of labour units put in by each family. Community kitchens, community schools, cinemas and the like are operated for the benifit of the members. The Government of the country provides teams of tractors on rent, and the machines are worked by squads of village boys trained in tractor driving. The government also maintains tractor repair and service stations. In State farming, the land, implements and machinery belong to the government, and the farms are managed and operated wholly by government employees. All production is government property and the earnings are appropriated by the State. The joint-stock company farms are owned, managed and operated on behalf of the shareholders like any other joint-stock undertaking. The share holders' interest is limited to the dividends on their invested capital, and the investors may frequently change.

For the achievement of the several purposes of Indian agriculture, only such systems of group cultivation should be adopted as are suited to our special social and political conditions, are likely to be acceptable to the community, and are calculated to give maximum production and to serve the best interests of the largest number. Consolidated managed farming is practised in some parts of U. P., Punjab and the Deccan, but it has not made much progress. The results of group allotment of land in the rehabilitation of refugees in East Punjab will be watched with interest. Collective farming on the Russian model has yet to be tried. Enquiries made so far do not show that it has been practised really successfully on a large scale in any part of India. The love of the Indian farmer to own a private farm, no matter how small, does not hold out bright prospects for collective farming under our existing conditions. Even the landless agricultural labourer has so far fought shy of hitching his wagon to this Russian star. State farming cannot be practised widely with our limited financial resources. However, it will be useful in the production of pure seed of improved varieties, and in the poineer development of large project areas and such other government land which for one reason or another do not attract the private farmer in the beginning. After developing such areas as State farms, the developed lands can be sold or leased to societies or companies willing to operate them on a group basis. Cooperative and joint-stock company farming are the two systems that hold out the greatest promise.

COOPERATIVE FARMING

As mentioned already, cooperative farming implies the coordination of the work of many small farmers and the pooling of their resources. It is common knowledge that the production of protective foods like milk, eggs, fruits and vegetables is largely in the hands of small producers. Small farmers practising intensive mixed farming seem peculiarly well-suited to the production of these protective foods. These competitive small farms aided by cooperative processing, grading and marketing will do particularly well in the vicinity of towns. Fresh protective foods are always in great demand in urban areas. Since most of these fresh foods deteriorate rapidly, their producer is at the mercy of the middlemen. He has to sell his perishable produce at any price that the middlemen offer him for it. Large arrivals on any one day depress the price disproportionately. The wholesale sellers and the retailers appropriate the major portion of the price paid by the consumer. Cooperative working of these small farms will yield many advantages. The cooperative societies can own and operate cold stores and thus make possible the orderly marketing of the produce of their members. They can also purchase processing and labour saving machinery and hire it out to their constituents. Purchase of such machinery by individual farms of small means is not feasible. There will not be enough use for it on a small farm and it will remain idle for long periods. Costly improvement of farms by mutual help can also be carried out. This does not imply that government Agricultural Departments will give no aid to these cooperative farms. The Agricultural Departments will continue to give techincal advice and guidance, and supply pure bred stock of high quality at market or concession prices. They will also assist in the control of insect pests and plant diseases.

JOINT-STOCK FARMING

It has been pointed out already that the national self-sufficiency in food needs an increased production of cereals, pulses, potatoes and oil-seeds particularly. The private small farmer with his limited means does not seem capable of effecting this large increase. Extensive farming under centralised expert management applying scientific technique to push up yields to the furthest limit is best calculated to achieve this end. The increased production of cotton, oil-seeds and jute, the raw products of industry, can also be obtained by the same means. The institution of joint-stock farming is, accordingly, suggested.

For long, agriculture including food production has been an individual effort. The small or the large farmer, as the case may be, has borne all the risks of a highly risky industry. Neither the consumer of agricultural produce, nor the government has come forward to share his risks or offer him an insurance against failure or calamity. We have now reached a stage when agriculture should be so organised that

(*i*) the producer gets an adequate return on his capital and labour;

(*ii*) the country's requirements of food and other agricultural products are met in the most efficient and economic manner; and

(*iii*) the consumers as well as the government take their due share in the risks and vicissitudes of production.

This means *organised production*. Our national requirements of food, fibres, oil-seeds and the like are now known with fair accuracy. Their entire production within the country is not beyond our capacity or resources. I am in full agreement with Mahatma Gandhi when he says that India must produce all the food she requires. We must plan, systematise and organise farming in the same way as we have organised industrial production. Of course, the evils of industrialisation must be avoided.

The growing of food and rotation crops, that lends itself easily for transformation into large scale corporate enterprise, should be classed as a key industry. It is absolutely vital to national existence and development. Therefore, it should be nationalised, and planned and developed under national auspices. As in the case of supplies of water, electricity and transport, the supply of sustaining food to every one should be a national duty. No public utility company could undertake a better service. The government should encourage, promote and give all possible facilities for the establishment of *'public utility companies'* for the production of food grains, cotton, jute and oil-seeds.

EXISTING UNDERTAKINGS AND THEIR DEFECTS

Farming by joint-stock companies is not entirely unknown in India. Tea, coffee, rubber, cinchona and sisal are already being farmed by them in several places. Many sugar factories meet at least a part of their cane requirements from estates owned and managed by themselves. The British Cotton Growing Association, Ltd., Khanewal in West Punjab, and Sind Land Development, Ltd., at Mirpurkhas in Sind are enterprises growing wheat, cotton and other field crops on extensive areas every year. There are one or two companies in West Punjab managing large sized fruit farms and also manufacturing syrups, squashes and preserves from the fruits grown by them. Similarly, there are a few dairy farms operated as joint-stock enterprises. However, most of the existing undertakings have private profit as their sole basis. Their primary responsibility is to their share-holders. Increased production to meet national needs is not their basic motive. Similarly, advancement of the economic status or efficiency of the agricultural labourers employed by them, or a conscious improvement of cultivation methods practised in their neighbourhood form no part of their declared objectives. Their primary aim is to earn the largest possible dividend on the capital invested. The use of labour saving machinery is designed to lower the costs of production and not to make the work less exacting for the labourer, or to afford leisure to the workers for enjoyment or self-improvement. Finally, the workers have neither a share in the profits of the concerns, nor a hand in their policy or management. No doubt they receive bonuses in years of good earnings, but these are not adequate incentives for them to take a keen, intelligent or anxious interest in the affairs of their employers. However, all these defects are removable, and they cannot be used as an argument to rule joint-stock farming out of court. I have mentioned these defects to ensure that the undertakings suggested by me should be free from them.

Farming by public utility companies of my conception should necessarily provide for the following:

(*i*) The production of food grains should be their *primary objective.*

(*ii*) They should be financed jointly by the government, farmer-producers and the consumers.

(*iii*) They should be under expert, centralised management.

(*iv*) The policy should be determined by a Board representing government, farmers and the consumers.

(*v*) The farmer-members should actively work on the estate as partners, and receive an adquate share of the net profits as remuneration.

(*vi*) The government should finance research and experimental work needed for the area of operation.

(*vii*) The government should receive a fixed percentage of net profits as dividend on the capital invested and in lieu of water rates (if any) and land assessment.

(*viii*) The annual dividend on the investment of the consumer-members should be limited to a maximum of, say, 10 per cent.

(*ix*) The government should have the first option on the purchase of all food grains which may be surplus to the legitimate requirements of the people employed in the concern.

(*x*) Ample funds should be set apart in the annual budget for training workers to increase their efficiency and for providing social amenities for them.

(*xi*) The methods of farming should be such as will produce maximum yields per acre without destroying soil fertility.

Given these conditions, farming by the proposed Public Utlity Companies will, on the one hand, put into practice the principles laid down in the All-India Congress Committee's resolution on the economic programme for the country, and, on the other, hasten the solution of our post-partition agricultural problems and also the tempo of the development of national resources to achieve self-sufficiency in food and other agricultural produce. It will also translate results of research into general practice and give a powerful fillip to rural reconstruction.

A UNIQUE PLAN OF LAND DEVELOPMENT

Finally, I may be permitted to describe briefly the unique plan that has been successfully worked in Sudan during the past 20 years for the development of irrigated cultivation under the Sennar Dam on Blue Nile. In 1911, 14 years prior to the construction of the dam, the Sudan Government erected a pump along the river Nile and canalised about 5,000 acres for the purpose of carrying out experiments to ascertain what crops were most suited to irrigation in the soil and climate of the tract. The whole area was rented from the owners and sub-let to tenants. The management of this experimental project was entrusted to the Sudan Plantations Syndicate, Ltd. At the commencement of this experiment, the tenants were charged a fixed rate for the supply of water, and the Syndicate were appointed as managers until such time as the experiments should be proved a success. Only two years later when success appeared assured, it became necessary to find some more

permanent basis for cooperation between the government, the Syndicate and the cultivators. After careful consideration it was decided to introduce the profit sharing arrangement which later became the basis for the development of the whole of the Senner project area of about 300,000 acres. Under this arrangement, the Sudan Government undertook the responsibility for the financing and running of pump and supplying the capital for "major" canalisation. The Syndicate became responsible for the "Minor" canalisation, for management of the whole enterprise, and for financing the tenants. The tenants were made responsible for supplying the labour as cultivators. It was also decided that the net proceeds from cotton, the principal cash crop grown in the experimental project, should be divided into portions of 35 per cent to the government, 25 per cent to the Syndiate, and 40 per cent to the tenants, while all other crops should go to the tenants. This arrangement proved very equitable and successful. "Any fixed charge that would have given a reasonable return (on government investment) must have been heavier than the man with bad crops could stand, and less than the man with good crops could afford, while the amount of the fixed charge would have appeared very frightening to the tenant. It (the profit sharing arrangement) has encouraged the provision of careful supervision, owing to the government and the Syndicate being directly interested in the actual results."

Subsequently an other experimental project, covering an area of about 6,000 acres was established in another part of the tract to test the conditions more fully than was possible at a single station. In this case the pump was erected and the land was canalised at the expense of the Syndicate. Four years before the completion of the dam, the Syndicate undertook another pumping scheme on an area of 19,500 acres, and two years later, yet another scheme on 30,000 acres. These last two schemes were undertaken with the express object of training in advance the required supervisory staff as well as the cultivators. The dam was completed in July 1925. As a result of the preparations made by the Syndicate, tenancies for 240,000 acres were allotted in the very first season, and 80,000 acres were actually sown to cotton, 34,000 acres to millet and 6,000 acres to the leguminous crop *lubia* (*Vigna catiang*).

For the efficient working of the scheme in rectangular blocks of uniform size, it was found incumbent that the land should be wholly under the control of the government. Accordingly, the government leased all the land included in the scheme from its registered owners for 40 years at a fixed annual rent. The rent was fixed at the highest rates obtainable before the commencement of the scheme. After renting, it was re-allotted to the actual owners in the form of cultivating tenancies for plots of regular size of 30 acres each, the owners getting the allotments in positions lying as near as possible to the position of their original holdings. No single tenant was given more than 30 acres to cultivate, but if he was the registered owner of a larger area he was permitted to nominate cultivating tenants to the excess. These nominees were in many cases the owners' sons or relations. Although tenancies were given for one year only, yet tenants who worked well were not allowed to be turned out by the land owners. Similarly, the owner-cultivator was permitted renewal of his tenancy from year to year provided he complied with the specified conditions of cultivation. Thus, on the hand, a reasonable security of tenure was given to all the tenants, and on the other, it was ensured that inefficient cultivators and slackers would not impede the development of the project area.

Each land-owner who became a tenant under the scheme, instead of being a cultivator on his own land, received a rent for his land and cultivated as a tenant on an irrigation plot as near as possible to his own original land, and if he was the owner of more than 30 acres, he had the right to put in his sons or other nominees as tenants of other plots upto the full area of the land he owned. On each plot of 30 acres, he was entitled to grow 10 acres of cotton, and 10 acres partly of green fodder for cattle and partly of grain crop for his own consumption.

Under the scheme, each cultivator gets the best seed distributed to him, he has the benefit of all the expensive scientific research which is being done by the government and the Syndicate for discovering the best manurial and cultivation treatments of crops and the means to control insect pests and diseases, and the marketing of his cotton crop is managed to the best advantage so that instead of being at the mercy of the local merchant he receives the highest price obtainable. He gets cash advances at a low rate of interest throughout the cultivation season to meet his living expenses, and he gets the advantage of ploughing machinery to plough his land. Of the proceeds of the sale of the cotton crop, after deducting only the actual cost of ginning and marketing, he receives 40 per cent as his share, and further, has the benefit of all other crops which he may grow free of all deductions or taxes. This compares very favourably with the position of tenants in other parts of the country, where they receive 50 per cent of the gross receipts but have to pay land rent and government taxes out of their share. Finally, the land-owner retains his free-hold rights and is entitled to bequeath his property to his descendents according to the Mohammedan law. However, to prevent land speculation, the government took powers to prevent sales of lands to foreigners or alienation of land to native usurers. Contracts of the purchase of land were made subject to the approval of the governor of a province, and it was decreed that the consent of the governor of the province would not be granted to "any sales or dispositions by the natives of the Sudan of lands in the Gezira effected after the 1st July 1905, except of such sales to other natives of the same locality as have hitherto been customary and may be deemed by the governor to be proper."

I need not give any detalied description of the administration set up by the Syndicate for the work of managing the whole business on the agricultural side. It is enough to state that this work comprises "training and supervising the tenants, seeing to the digging of the field channels and the clearing of the ground, carrying out the levelling and the ploughing, supervising the sowing and growing of crops, making advances to the tenant cultivators to cover their working expenses during the early part of the year before the proceeds of sale of cotton come in, and arranging for the collection, sorting, ginning and marketing of the crop". The Syndicate helps both the government and the cultivators in many other ways. The results obtained from these arrangements have been eminently satisfactory. The income of the cultivators increased so much that after the first two or three years, many of them stopped taking advances from the Syndicate, and some of them built up adequate funds to take to trade and other subsidiary occupations. This has helped to raise the standard of living and increase greatly the local circulation of money.

I suggest that the example of this profit sharing experiment of Sudan should be followed in India for the rehabilitation of refugees and the rapid

development of the irrigation projects now under contemplation. No doubt adjustments will be needed in the scheme to suit local conditions but they can be made when details are being worked out.

The time has come when we should talk less and act more. We have got ready many plans for agricultural development. What is necessary is to put one or more of them into action without delay. The need for making the country and its different Provinces and States self-sufficient in respect of food production is most urgent.

SECTION OF MEDICAL AND VETERINARY SCIENCES

PRESIDENT: DR. G. D. BHALERAO, Ph.D. (Fac. Med. London), D.Sc. (London & Allahabad) F.Z.S., F.R.M.S., F.A.Sc.

BLOOD-FLUKE PROBLEM IN INDIA

(Delivered on January 6, 1948)

I am grateful to you for the great honour you have done me in electing me to preside over this section. I have been interested in blood-flukes of man and domestic animals for the past eighteen years and for this reason I have fixed upon this subject for my address. Moreover, it is a subject in which people of both veterinary and medical professions will be interested alike. Compared with any other single group of parasites, blood-flukes or schistosomes rank foremost in undermining the health of almost all domestic animals in India, and although the exact data in this connection are not available it will not be an exaggeration to say that they cause much inconvenience and harm to our live-stock and inflict considerable monetary loss upon stock-owners in this country. Control and, if possible, extermination of this class of parasites therefore deserves our primary attention particularly at this juncture when there is an acute shortage of food all over the world and "Grow More Food" is the stock phrase of the authorities concerned. In addition to the loss thus suffered indirectly by the people the possibility of human schistosomiasis taking its root in this country has not been finally ruled out. Reference to this and to the condition in human beings known as "Schistosoma Dermatitis" will be made in the subsequent part of this address. The earliest record of the occurrence of schistosomes in India was made by Cobbold who in 1882, at the meeting of the Medical Chirurgical Society in London, declared that cattle and sheep in India are infected with schistosomes. Four years after this statement Bomford (1886) obtained oval eggs with a terminal spine, measuring 0.17 mm. X 0.08 mm., in the small portion of the cæcum of one bullock of the Transport Department destroyed in Calcutta and in another in the polypi or papillomata removed from the margin of the anus. The ileo-cæcal valve of these bullocks was so congested that it formed a thick cushion-like ring. Bomford remarked that these ova resembled those of *Schistosoma hæmatobium* which was confined to man or monkey and had never previously been recorded from India. He also remarked that it would be interesting to ascertain if hæmaturia in cattle in some parts of Bengal could be associated with bilharzial parasites. Montgomery (1906), however, expressed the view that these ova could not be of *S. hæmatobium* but they really belonged to the species *S. indicum.* The nature and dimensions of the eggs substantiate the contention of Montgomery. As a result of the work of Montgomery (1906) and that of several other workers during the past three decades seven authentically identified species

of schistosomes have been recorded from India, *viz.*, *Schistosoma hæmatobium*, *S. spindalis*, *S. nasalis*, *S. indicum*, *S. incognitum*, *Ornithobilharzia bomfordi* and *O. nairi*. Of these the first one has been sporadically recorded from man, while the remaining six have been known to parasitise only the domestic animals. In the following pages I have endeavoured to give an idea of the work that has been done in India on these parasites and suggest in the end measures for their control. As has been remarked before reference will also be made to cercarial dermatitis of man, which so far as the researches of the author have progressed appears to be localised only in certain localities in India.

Schistosoma spindalis Montgomery, 1906.

Montgomery (1906) first found *Schistosoma spindalis* in the mesenteric vessels of two plains cattle (*Bos indicus*) at Mukteswar, and described the morphological features of the adult worms and their spindle-shaped ova. Among his autopsies only one presented lesions analogous to those described in other species of schistosome infestation. This animal suffered from intense and fœtid diarrhœa and at the post-mortem the whole of the cæcum and the colon to within three feet of the anus were covered with small warty nodules varying in size from a pin head to a lentil, the apices of which were for the most part coated with yellow caseous material; in others recent capillary hæmorrhage had taken place. He found in cattle pin point hæmorrhages in the colonic mucosa containing terminal spined ova designated as *S. bomfordi* and in the large hæmorrhages spindle-shaped eggs resembling *S. bovis*, which Montgomery named *S. spindalis*. Presumably the animal referred to above suffered from a mixed infection. Liston and Soparkar (1918) when investigating the possibilities of the spread of human bilharziasis in India through the arrival of infected troops found a furcocercous cercaria in one of the fresh-water molluscs, *Indoplanorbis exustus*, met with locally in Bombay. They successfully transmitted infection to guinea-pigs, recovering male *Schistosoma* worms at autopsy, but failed to infect experimentally a monkey of the species *Macacus rhesus*. Later they infected a young kid via the cutaneous route. About seven weeks later the animal developed diarrhœa and spindle-shaped ova containing active miracidia corresponding to Montgomery's description of *S. spindalis* were recovered from the fæces. The kid developed severe anæmia, diarrhœa, paraplagia with œdematous swelling under the jaw and round the neck and a fortnight later it died. Post-mortem showed numerous worms in all stages of development in the liver and the larger portal veins were literally packed with worms, the females containing the characteristic spindle-shaped ova. It is also interesting to note that Christophers and Stephens (1905) recorded the occurrence of spindle-shaped ova in the urine of a Madras native suffering from *S. hæmatomium*. Liston and Soparkar (1918) also traced the miracidium through a sporocyst stage in the liver of *I. exustus* with production of cercariæ. Soparkar (1921) gave a detailed description of the cercaria which has four pairs of flame-cells in the body and one pair in the tail. There are five pairs of cephalic glands, the anterior two of which are coarsely granular and the posterior three finely granular. Soparkar further observed that the cercariæ mainly occur in *I. exustus* and rarely in *Limnæa acuminata*. Rao (1934) corroborated the observations of Soparkar and further described the miracidium of *S. spindalis*, in which the anterior excretory glands are shorter than the gut, the number of cilliary groups on the girdle are 6-8 and the germinal cells are large and quadrangular. Bhalerao (1943) added *Limnæa luteola* to the list of the intermediate hosts of *S. spindalis*.

Bhalerao (1932) discovered in cattle from Bihar another variety of *S. spindalis*, in which the males had a smooth cuticle, whereas the males described by Montgomery (1906) had a tuberculate cuticle. The utirine eggs of the females of this variety were smaller in size and measured 0.258-0.46 X 0.063-0.070 mm., in which respect they converge to the variety *africana* Porter, 1906. These observations were corroborated by the author's own observations on this variety collected from several localities in India and by Rao (1934) from specimens collected from cattle in Madras. As a matter of fact both the author and Rao did not find so far a typical *S. spindalis*, with males having tuberculate cuticle, as described by Montgomery (1906).

Fairley and collaborators in the years 1925, 1926, 1927 and 1930 infected artificially buffaloes, goats, monkeys and guinea-pigs with the cercaria of *S. spindalis* obtained from *I. exustus* and made some valuable observations. The buffaloes and goats developed the disease but monkeys were found to be naturally immune. In guinea-pigs only the male worms developed. In monkeys schistosomulæ were demonstrated in the pulmonary, portal and mesenteric vessels on the 11th day; on the 23rd day all living schistosomulæ had disappeared, but pathological lesions were still present in the liver, whereas on the 124th day there remained no evidence of cercarial infection. Within six days of infection the serum of monkeys gave a positive complement fixation test. The maximum fixation of complement was observed on the 39th day following exposure and negative reactions were established by the 83rd day. It is suggested that the phenomenon is one of true natural immunity which is conferred on the species in virtue of some inherent unsuitability of the blood of monkeys to afford a suitable medium for growth of schistosomulæ, once they have attained a certain stage of development.

In guinea-pigs penetration of cercaria occurs via the hair follicles. Hepatic lesions characterized by verminous phlebits and the thrembosis were constantly produced by male worms. It is suggested that some host factor antagonistic to the development of female schistosomes underlies the phenomenon of exclusive male survival rather than an initial unisexual infestation.

In buffaloes which were infected with nearly 60,000 cercariæ of *S. spindalis* the schistosomes were found after three months in the portal and mesenteric veins and their branches, while ova containing living miracidia were demonstrated in the liver, large and small intestines. Bilharzial pseudotubercles were observed in the liver and characteristic microscopical appearances and also thrombosis in the periportal zones. Intravascular deposits of ova were frequently observed in the infiltrated clot and in a few instances disintegrating schistosomes were also demonstrated. In view of the acquatic habits of water buffaloes, and the frequency with which they inhabit water tanks, it is believed that they constitute chief definitive host of *S. spindalis*.

In goats, during the first three or four months after infection with *S. spindalis* cercariæ, paired adult worms inhabit not only the mesenteric and portal veins and their branches, but they may wander further afield into such locations as the gastric, splenic, pancreatic and renal veins, the inferior vena cava, the pulmonary artery or the cavities of the heart. Observations on the sex ratio revealed that the males and females were in proportion of 100: 48. Ova appeared in the uterus of the female worm within six weeks and were deposited in the tissues within seven weeks of exposure to infestation. The average number of ova per female was 9.1. In the early phases

of the disease, especially in the hyperinfected animals, worms are widely distributed and dead schistosomes are constantly demonstrable; later a biological equilibrium is established and after this the parasites survive indefinitely in the portal system of the host. Lesions occurring prior to the deposition of ova include verminous phlebitis involving branches of the mesenteric and portal veins, and toxic changes in the liver and kidneys. Pseudotubercles and periportal cellular infiltrations also occur in the liver. Hepatic pseudotubercles, verminous phlebitis of the main portal vein, and its intrahepatic branches, mesenteric thrombosis and periportal cirrhosis constitute the more common later manifestations. Macroscopical lesions in the small and large intestine are uncommon though egg deposition occurs in 92.6 per cent and 96.2 per cent cases respectively. They are also deposited in the liver, next in frequency in the portal and mesenteric glands, the gall-bladder, the lungs and the pancreas. Rarely they are demonstrated in the spleen, kidney or bladder, while ova have never been observed in the brain, spinal cord or heart muscles. The ova of *S. spindalis* appear to have very little effect on the gut of infected goats. They are deposited in the submucosa but no clinical intestinal symptoms result and even microscopically the local reaction round the egg is remarkably slight. The toxic effect appears to be derived from the parent worm rather than the ova. It is the toxic product from the miracidia that give rise to inflammation reaction, with vascular dilatation and cellular infiltration of the tissue in their vicinity.

It has been observed that alimentary infection with schistosome cercariæ occurs only in ruminants owing to the peculiar anatomical and physiological differences in the stomach of these animals. The alkaline and neutral reaction of the contents of the rumen, reticulum and omasum must predispose to gastric invasion not only by prolonging the life of the cercariæ but also by increasing the area of mucosa available for invasion. Cercarial invasion via the upper alimentary tract appears to be the usual mode of infestation in goats. Consequently they can be succesfully infected with cercariæ contained in drinking water pipetted into the buccal cavity as well as by direct introduction into the rumen by means of a stomach tube. Schistosome cercariæ cannot survive the normal acidity of the gastric contents in animals other than ruminants.

As a result of an extensive survey it has been found in areas around Bombay that 2 per cent of *I. exustus* are infested with cercariæ of *S. spindalis* and that there is a definite seasonal incidence. The lowest infective rates were observed during the monsoon months from June to September and the highest during the cool period from November to March.

Fairley and collaborators developed in this country serological method of diagnosing bilharzial infection. Antigen was prepared by extracting with alcohol dried, powdered livers of *I. exustus* infested with the cercariæ of *S. spindalis*. An extract prepared with absolute alcohol was found to be highly antigenic, acting upto a dilution of 1 in 600. Similar extracts of dried powdered cercarial liver were made with 99, 75, 50 and 30 per cent alcohol. All were potent antigens acting efficiently in dilution of 1 in 600 for the 90 and 75 per cent extracts, 1 in 400 for the 50 per cent and 1 in 300 for the 30 per cent extract. The antigen which reacts with specific antibody in the complement fixation reaction for *Bilharzia* is a lipoid or lipoidal complex of colloidal nature; previous workers, however, indentified this antigenic factor with the protein or allied constituents of these extracts. Extracts prepared with more dilute alcohol have the advantage of lower lipoid content and in

consequence show a lessened tendency to fix the complement in the presence of syphilitic sera of man. It is, however, quite possible that by appropriate dilution of concentrated alcoholic extract to work outside the zone of pseudo-positive reaction to syphilitic sera and still preserve in high degree specific antigenic function. As a result of numerous complements fixation tests it has been concluded that the cecarial antigen of *S. spindalis* is of a group nature and can be used successfully in detecting infestations *S. hæmatobium, S. mansoni, S. japonicum, S. bovis, S. spindalis* and *S. indicum*. Since no other clinical means is available for determining the incidence of unisexual infestation in man serological methods alone could be used successfully in such cases. One more aspect of immunology is opened up by such observations; namely the possibility of establishing a broad classification of cercariæ along these lines. By testing various alcoholic extracts of different furcocercous cercariæ against a known positive bilharzial serum it is already possible to state whether a given furcocercous cercaria is the larval stage of schistosome or not. Thus a serologist can effectively help a zoologist. Alcoholic extracts of the livers of normal snails (*I. exustus*) or of snails infected with non-bilharzia cercariæ were found to be quite devoid of antigenic properties when tested against bilharzia sera.

Pleural, peritoneal and pericardial transudates and exudates will yield positive complement fixation reaction in infected animals provided the blood shows similar reaction. In several instances specimens of cerebro-spinal fluid derived from animals whose blood gives strong serological reactions have been examined by complement fixation test, but always with negative results, showing that antibody does not traverse the choroid plexus. With the possible exception of the liver-fluke it will be seen that in animals positive reactions invariably mean infection with some mammalian schistosome.

Experiments of Fairly show that *S. spindalis* antigen was quite effective in diagnosing the vesicle form of schistosomiasis. In man owing to lipoidal nature of the antigen greater care is necessary in order to eliminate pseudopositive reactions in syphilitic sera. In the first place antigen should be prepared from heavily infected livers and in many doubtful cases the alcoholic extract should be evaporated to dryness and then emulsified with saline. The tendency to pseudopositive reaction in syphilitic sera is accentuated by age, so that wherever possible a serum should be examined within twentyfour hours of collection.

The reaction inexperimentally infected goats shows that complement fixation reactions persist as long as the definitive host continues to harbour living schistosomes. Intravenous injections of alcohol-soluble cercarial extracts into goats infected with *S. spindalis*, though causing a marked increase in the antibody content of the serum, entirely failed to modify the course of the disease.

Fairley (1926) tried tarter emetic on alternate days or at slightly longer intervals in animals infected with *S. spindalis*. Clinical cure was effected in a majority of cases but therapeutic results were disappointing in some. In a subsequent series where a similar dosage was employed but injections were given at closer intervals highly satisfactory results were obtained. As a result of these experiments the conclusion was reached that tartar emetic in doses of 3.9 to 5.5 mg. per kg. of body weight, continued daily for from sixteen to twenty-six days, is capable of curing *S. spindalis* infection in goats. It was observed that female worms are affected more by anthelmintics than

male ones. The surviving females show a much lower ova count. Intravenous injections of emetine hydrochloride, in ten to fifteen daily injections, varying between 0.7 and 1 mg. per kg. of body weight, resulted in 100 per cent. clinical cure. The drug has more efficient anthelmintic properties than tartar emetic, but is more toxic and the cumulative effects develop at an earlier date. Some animals died from verminous thrombosis of the pancreatic vein during or after effective treatment with emetine hydrochloride. This complication was essentially due to hyperinfection with *S. spindalis*, and might have occured with any specific drug exerting a rapid lethal action on a large number of parasites.

Observations were also made on the length of the survival of antibody in animals treated with anthelmintics such as tartar emetic, emetic hydrochloride and urea-stibamine. In a number of clinically cured animals negative reaction became established some 4 to 28 weeks after intravenous medication. In detecting circulating antibody following treatment, the ice-box method of complement fixation generally proved more sensitive than the warm method. The result of the ice-box technique were not, however, equally reliable in cases of non bilharzia sera. Occasionally pseudo positive reactions of positive type were recorded.

Schistosoma nasalis Rao, 1933.

Unlike other species of *Schistosoma*, *S. nasalis* occurs exclusively in the nasal veins of the hosts. Usually cattle and rarely buffaloes are infected, but sporadic cases of this infection occurring in goats and one solitary instance of an equine infection were brought to the notice of the author. The male of this parasite has a prominently tuberculate cuticle and the ova have the shape of a boomerang or the Napolean's hat, with a spine at one end. The lesions produced by the parasite extend from the anterior nares to the posterior part of the nasal chamber and can be observed on the nasal septum, the turbinal bones and the ake nasi. The infection of the definitive host occurs through the nose while the animal is drinking water infested with the proper kind of cercariæ. About six weeks after the initial infection there is congestion of the nasal mucous membrane, coryza end sneezing. Ten days later there is more mucus discharge and the mucous membrane becomes œdematous. About eleven weeks after infection raised patches are studded over the œdematous mucous membrane. These contain the characteristic ova. At this stage the nasal discharge becomes thickened and apears more or less mucopurulent, which later turns rusty and streaks of blood are noticeable in it. There is narrowness of the nasal calibre giving rise to peculiar snoring sound during respiration, from which the disease is colloquially called "Sun Suna" in certain localities in India. Shortly, abscesses appear on the patches and burst. After bursting of the abscesses the patches subside and the breathing again becomes lese noisy. After a lapse of some days the lesions reappear and the breathing again becomes distressing. Microscopical examination of the nasal discharge reveals the presence of the peculiarly shaped ova and in a thinner discharge could be detected the miracidia as well. The disease is known to all veterinarians in this country as Nasal Granuloma which is, however, quite distinct from the nasal granuloma which is proved to be rhinosporidiosis by Krishnamurti Ayyar in 1927.

Microscopical examination of the morbid tissue reveals that the ova are primarily deposited in the submucosa. In sections passing through an

ovum, containing in some cases a well developed miracidium in it, there is central core and around this, with fibroblastic activity and eosinophilic infiltration, concentric rings of fibrous tissue gradually invade from the periphery inwards until the lesion may be considerably fibrosed, giving the entire structure an appearance of a typical bilharzial pseudotubercle. In advanced lesions, the ova undergo calcification or are desorbed or totally digested by the giant cells and no eosinophilia may be present in the altogether fibrosed nodule. The blood vessels are usually enlarged and in the majority of cases endophlebitis is produced by the liberation of the toxins by the worms contained in them. Around some vessels there is a cellular infiltration and fibrosis as noticed around an egg giving rise to similar pseudotubercles, finally leading to obliteration of the vessels. Defunct and degenerating parasites may bring about a thrombus formation. In some cases there is a rupture of blood vessels thus making it possible for the ova and some worms, particularly the females, to migrate into the perivisceral tissue.

The etiology of this disease was quite obscure until 1931 when the author accidentally recovered at Mukteswar a male worm from a piece of morbid tissue which was kept in saline in an incubator at 37°C. for about eighteen hours. Earlier Krishnamurti Ayyar (1925) was erroneously led to the conclusion that the disease was of actinomicotic origin. Since potassium iodide was found ineffective in alleviating the symptoms of the disease Dr. J. T. Edwards, the then Director of the Indian Veterinary Research Institute, Mukteswar, suggested in 1929 treatment analogous to human achistosomiasis. Cooper in 1931, however, wrongly concluded that, since tartar emetic was useful in the successful treatment of the disease, it must have been produced by some protozoon organisms such as those of Kala Azar or Surra. Malkani in 1932 published a short note on the etiology of this condition, declaring that it is a form of nasal schistosomiasis. The same year Datta (1932) published a paper giving exhaustive details about the symptoms and histopathology of the morbid tissue. In 1933 Rao and Malkani published independently their own observations on the symptomology, histopathology and other aspects of the disease.

According to the available data the disease occurs in Bombay, Madras, Central Provinces, Bihar, Assam, Orissa, Mysore, Bengal and also in Burma. Although the animals are actually infected during monsoon, clinical symptoms of the disease become manifest in the cold weather, the incubation period being approximately three months. Numerous cases of this disease are noticeable from November to March and in some notorious localities as many as 80 per cent. of the cattle fall victim to this affection.

A thorough description of both male and female parasite was first given by Bhalerao (1932). Later Rao (1933) and Malkani (1933) provided an indepedent account of this species. Researches of Rao, Sewell and Bhalerao proved that *Limnæa acuminata, L. luteola, L. amygdalum* and *Indoplanorbis* exustus act as the intermediaries of this parasite in various localities in India. Rao (1933, by his experiments on calves at Madras established that *Cercariæ indicæ* XXX Sewell, 1922 develops into *Schistosoma nasalis*. Sewell (1922) had given a detailed account of the anatomy of this cercaria. It has three pairs of flame-cells in the body and one pair in the tail. Its miracidia, as described by Rao (1934), has the anterior excretory glands longer than the gut, the girdle has 10-12 cilliary groups on it and the germinal cells are small and rounded.

Rao (1934) was also successful in artificially infecting guinea-pigs with the *Cercariæ indicae* XXX Sewell, 1922. He, however, recovered a few worms from the lungs, which were all males. Like *S. spinladis* guinea-pigs do not apear to be suitable media for the development of females of the species *S. nasalis* also.

Datta (1932) and Malkani (1932) advocated the use of tartar emetic in the treatment of Nasal Granuloma. Rao, however, used antimony tartrate and antimosan for the treatment of 8901 cases during the three years 1936, 1937 and 1938. Of these 33.8 per cent, were cured, 66.2 per cent were discontinued and there were only 25 deaths which works up to 0.002 per cent. According to Rao antimony tartrate is the drug of choice. Antimosan, a proprietary preparation, is comparatively non-toxic and is found valuable, but it is expensive. The dose of antimony tartrate is 1.5 grains per 100 lbs. of body weight given daily for six days or 2.5 grains per unit of body weight every alternate day. The dose of antimosan is 40 c.c. per 150 lbs of body weight. Antimosan has further advantage of its being given subcutaneously or intravenously and requires more amount of skill and care in administration. The drug kills both adult worms and ova. The small percentage (0.002%) of deaths may be due to faulty technique, individual idiosyncrasy or in rare cases worm emboli in the lungs. The toxic symptoms noted in the case of antimony tartrate were rise of temperature, disinclination to move, weakness of pulse, dryness of mouth and nose and unsteady gait. These last for about four days. They indicate that no further treatment should be given during that period and if proper precautions are taken the number of deaths could be reduced.

Schistosoma indicum Montgomery, 1906.

Montgomery (1906) published an account of bilharziasis in horses which were ill conditioned, weak, with harsh staring coat indicative of unthriftiness. He found that 9 out of 11 hill animals and 11 out of 15 plains animals were subject to this condition. There was in these animals passive congestion in the portal system. Mesenteric veins, especially of the colon and rectum, were enlarged so were also the pelvic veins. The liver in all cases was in a state of chronic venous congestion. It was studded with chronic pearl-like nodules, varying up to the size of a pea, well defined by a fibrous capsule and easily enucleated. The mucous memorance of the large intestine showed small petechial hæmorrhages, its wall being slightly thickened and the submucous capillaries dilated and congested. In donkeys the lesions were analogous to those of horses.

Montegomery (1906) observed that the alimentary canal of sheep, from the pylours to the margin of the anus, infected with *S. indicum*, was studded with small areas of distinct punctiform hæmorrhage. Observations of Baldrey in 1906 on sheep at Lahore and those of the author on sheep from Sind, Punjab, Assam and Bihar indicated the presence of numerous nodules throughout the intestinal canal. On examinations these nodules revealed the presence of *S. indicum* and their ova. The affected animals suffered from persistent diarrhœa and œdematous swelling in the submaxillary region. In some localities such condition is known as *'Pitto' or 'Gillar'*. In parenthesis it may be remarked that more or less similar clinical picture in ovines is produced by the infestation of immature amphistomes.

Leese (1911) recovered *S. indicum* from the mesenteric veins of the small and large intestines, portal veins and the veins of the omasum of six camels. All these veins were in a state of passive congestion.

Datta (1933) published a paper describing the nodular portal cirrhosis in enlarged livers of horses in India, causing persistent debility and heavy mortality as due to the ova of *S. indicum*. He published a report of eight cases, described the morbid anatomy of various organs of the horse and discused the methods of diagnosis and control of the disease. The liver of these horses was riddled with numerous calcified, greyish white nodules of the size of sago or pea, at the centre of which was the ovum of the worm, with a disrupted shell. Only in one case could Datta detect a female at the centre of the nodule. The portal veins were dilated, majority of them being obliterated or occluded. The developing miracidium inside the egg is readily destroyed by the phagocytic action. It is remarkable that the liver cells remained healthy for a remarkably long period. Although bilharzial lesions are usually restricted to the large intestine, they may encroach upon the small intestine and in rare advanced cases, even upon the stomach. The mucous membrane is ulcerated, but no layer of the gut wall is found to be free from the lesions, although in every case the venules in the submucous coat are the only seat where the pseudotubercles are produced around six or more ova. It is remarkable that in equines the schistosome ova are found below the mucous membrane but in ovines and bovines the eggs are restricted to the mucous membrane only, where the actual lesions are more cellular than fibrous and not calcareousat all. Mesenteric, portal, mediastinal and bronchial glands are also affected. Pseudotubercles at varying stages of fibrosis and calcareous degeneration are encountered throughout the glands. Some glands may reveal only an endarteritis, eosinophilia and a hæmorrhagic appearance. Pleura and the lung parenchyama also exhibit bilharzial regions. The nodules may reach the size of a green pea. A moderate enlargement and hyperæmia may be the only lesions in the spleen and these are due to portal statis. Ordinarily actual nodules are seldom encountered but in extreme cases there may be many of them. Brown granules of blood pigment and eosinophilia may be seen at places. Evidence of ascitic fluid may or may not be present.

There exists in India a disease of equines, known locally as *Kumri*, which resembles to a large extent, the better known condition of equine paraplegia. Malkani (1933) reported the occurence of *S. indicum* worms from the liver and portal circulation of two *Kumri* ponies in Patna. He obtained encouraging results by treating *Kumri* ponies with sodium antimony tartrate. On the basis of these two facts *S. indicum* has been looked upon by some as causing *Kumri* in horses. This fact, however, requires corroboration before it can be finally accepted, for numerous equine cases are known to the author in which *S. indicum* infestation did not produce *Kumri*.

Prior to 1932 *S. indicum* was known to occur only in the horse, donkey, sheep and the camel, when Bhalerao (1932) recorded its presence in cattle and goats from various localities in India. Montgomery (1906) was the first to describe this species, later Bhalerao (1932) added materially to the original description of this parasite. Amongst other things may be mentioned the range of the variation of the number of tests, which is 5-12 and not 5-9 as was previously known. The female worms obtained by Leese (1911) were somewhat different from those of Montgomery in respect of the proportion of the length of the paired cæca to that of the common cæcum, but Professor Leiper, to whom the specimens were referred, considered it to be an unreliable specific point of distinction. The life-history of this important parasite still awaits elucidation.

In passing, it may be remarked here that all previous records of the occurrence of *Schistosoma bovis* in this country appear to be erroneous. In spite of extensive investigations of the author and those of Rao this species has not yet been encountered in domestic animals in this country. Malformed eggs of *S. indicum* appear to have been mistaken in the past for those of *S. bovis*.

Schistosoma incognitum Chandler, 1926.

Chandler (1926) recovered from the supposed human stool asymmetrical schistosome eggs with a subterminal spine on the slopes of a tank in a village near Krishnagar in Bengal. Another case of the same infection was found by him in the vicinity of a village of Nepalese on the outskirts of Kalimpong in the Himalayan foot hills on Northern Bengal. The eggs in the two cases measured 95 × 41.5-43 μ and 95-100 × 45-50 μ respectively and the spine was 7.3 μ long. In the localities from which these supposed human stools were collected pigs were common. In addition to the schistosome ova, in the first case hookworm ova were also detected and in the second the ova of *Ascaris, Trichuris* and the hookworm. This made Chandler confirmed in his belief that the stools from which he had obtained these peculiar ova were of human origin. Chandler assigned these ova to a new human species of *Schistosoma, Schistosoma incognitum.*

Rao and Ayyar (1933) discovered a new schistosome in pigs in Madras, which they designated *Schistosoma suis.* The eggs of this species are flat on one side and measure 90 × 41 μ. They have a subterminals pine which is 7.5 μ long. A comparison of the eggs of this species with those described by Chandler (1926) led the joint authors conclude that both were identical. They further remarked that the fæces from which Chandler obtained ova were of pigs and not of human beings, for *Ascaris, Ancylostoma* and *Trichuris* are common both to pigs and men. This appeared to the author probable and he (Bhalerao, 1938) suggested that according to the International Rules of Zoological Nomenclature *S. suis* should fall into the synonymy of *S. incognitum,* the latter name having a priority.

Sewell (1919) recovered *Cercariæ indicæ* XXX from *Indoplanorbis exustus* and *Limnæa amygdalum* from a tank in Calcutta. The cercaria had three pairs of flame cells in the body and one pair in the tail. It had five pairs of cephalic glands. On comparison Sewell found that this cercaria was indistinguishable from that of *S. japonicum* except that the former had a slightly smaller body and a trifle longer tail. Although the anterior two pairs of cephalic glands of *Cercariæ indicæ* XXX had coarsely granular protoplasm and the posterior three finely granular protoplasm. Sewell did not attach to this differentiation any value, dismissing it with the remarks that this differentiation is merely physiological and not morphological. Being led by this assumption Bhalerao (1934) described male schistosomes collected by Dr. P. A. Maplestone from the intestines of pigs in Calcutta, which he regarded as a variety of S. *japonicum.* A comparison, however, of these specimens with those from pigs in Madras obtained by Rao and Ayyar convinces the author, beyond any shadow of doubt, that both the specimens are identical and the schistosomes from pigs in Calcutta can now be rightly assigned to the species *S. incognitum.* Moreover, as has been stated in the earlier part of this address, Rao (1934) proved experimentally that *Cercariæ indicæ* XXX develops into *Schistosoma nasalis.*

In addition to porcine hosts *S. incognitum* parasitises dogs as well. Rao and Ayyar (1935) discovered the ova of this species in the fæces

of a dog from Jubbulpore that was brought for treatment at the veterinary hospital, Ootacamund. This dog was suffering from persistent dysentary for the past six months. The owner had lost previous three other dogs which also showed similar symptoms. A second case of this infection in a dog has been recorded by Rao (1937) from North Arcot district, which had frequent attacks of dysentery and was not keeping good condition. The eggs were quite typical and measured 90-120 μ × 40-00 μ and the spine was 5-7.5 μ long. Rao also described the miracidium in the egg, which showed "Shoulders" at its antero-lateral margin: a structure unknown in the miracidia of other species of schistosomes. Other interesting points in the anatomy of this miracidium are the absence of a cilliary girdle found in *S. japonicum* and the presence of six refractile rounded bodies in the region around the digestive tract. Subsequently to this the author has known three other cases of this infection in dogs from different localities in India.

Ornithobilharzia bomfordi (Montgomery, 1906) Price, 1929.

This species was found only once in a plains cattle at Mukteswar by Montgomery (1906) along with *S. spindalis.* Oval eggs with terminal spines were recovered from pin point hæmorrhages in the colonic mucosa. Since there was a mixed infection of *O. bomfordi* and *S. spindalis* in the animal it is extremely difficult to refer to the symptoms which could be produced by the former species alone. Amongst other characters, as the testes in a male number up to 70. Price (1929) assigned this species to the genus *Ornithobilharzia,* remarking that some bird must have been the definitive host of this species and the bovine infection was purely accidental. Although the author is in complete agreement with Price in assigning this species to *Ornithobilharzia,* it is highly sceptical how far Price was justified in his statement regarding some avian species being its definitive host, particularly in view of the fact that another species of this genus has been recorded from a mammalian host in this country, to which reference will be made presently.

Ornithobilharzia nairi (Mudaliar & Ramanujachari, 1945)
Bhalerao, 1947.

Mudaliar and Ramanujachari (1945) described this species from an elephant aged 68, working in Coimbatore forest, designating it *Schistosoma nairi.* The only symptoms prior to the death of the animal were gradual emaciation, debility and inability to work. The males measured 9.4 mm. in length, the cuticle was tuberculate and the testes numbered up to 52. The female was 10.5 mm. long, the ovary was situated at the anterior fourths of the body and the eggs, singly in uterus, were flat on one side, had a terminal spine and measured 80 × 30 μ. On account of the anatomical peculiarities of both male and female worms this species could not be retained in the genus *Schistosoma* and the author consequently assigned it to *Ornithobilharzia* in 1947.

Human Schistosomiasis.

There are only a few records in this country of indigenous human schistosomiasis. The first case was reported by Powell (1903) from a native of Bombay who had painless hæmaturia without constitutional effects. Numerous ova with terminal spine were detected in the urine. The second case was recorded by Sewell (1904) in a private of the 1st

South Wales Borderer's who passed dark coloured urine with numerous ova of *Schistosoma hæmatobium*. The patient was for four years in India and had never been to Egypt or South Africa. The third case was reported by Christophers and Stephens (1905) from a native of Madras, who was suffering from hæmaturia. In the urine were detected ova of *S. hæmatobium* and in addition long spindle-shaped ova with a terminal spine, measuring 205×53 μ. Wardrop (1906) described two cases of British soldiers who developed urinary bilharziasis in India six months after leaving England. These soldiers had never been out of England. Hooton (1914) recorded a case of urinary bilharziasis in a Parsi girl, aged 5 years, at Rajkot (Gujrat). There was pain on micturation and the urine was smoky, which later became definitely red, micturation was frequent and the child complained of burning sensation at the vulva and pain in the hypogastrium. Bilharzial eggs with a terminal spine were detected in urine. The girl had also a rise of temperature. After administration of calcium chloride for three days urine became normal, the ova disappeared from urine and the child was apparently in her usual health. Hooton suspected two other cases of this nature in the West Hospital Rajkot. Harkness (1922) reported a case of British soldier, aged 26 years, complaining of an urethral discharge on the previous day, itching of the penis, pains in the back and frequency of micturation during the past two months. He had had similar discharge and frequency of micturation two years earlier when on active service in India, where he was stationed for three years. Examination of urine revealed the presence of the ova of *S. hæmatobium*. The urethral discharge lasted for two days and then disappeared. He yielded to the treatment of sodium antimony tartrate.

Reference has already been made to the ova of *S. incognitum* obtained by Chandler (1926). Since this species has been so far recorded from pigs and not from human beings in this country, it appears more probable that the samples of fæces which Chandler examined were of pigs rather than of men. Investigators in future would do well to keep an eye on this infection in man, with a view to corroborate or refute the contention of Chandler. Mello (1936) quotes one definite autochthonous case of urinary bilharziasis in a child 9 years old, resident of the village Valpoy in Portugese Goa, where from 1912 to 1934 were living African troop infected with these trematodes. The child was admitted to the hospital for cystistis and dysentery and showed numerous ova of *S. hæmatobium* in urine and fæces. Recently Andreasen and Suri (1945) reported a case in a Sikh sepoy, a resident of Ambala district in the Punjab, who had never been out of India. He was for a short time in Poona where West African troops were stationed at the time. Following a trivial injury in sports, he noticed blood in his urine and for two weeks suffered from dull pain in the lower abdomen and at the end of the penis after micturation. Large number of ova of *S. hæmatobium* were detected in his urine, which disappeared after treatment with tartar emetic.

It will be evident from the above that only nine authentic cases of human bilharziasis have been recorded from India during the years from 1903 to 1945. It would therefore appear at first sight that human bilharziasis is not a very serious condition in this country. It, however, transpires from the above that some molluscs in this country are capable of harbouring the larval stages of the human schistosome, *S. hæmatobium*. Another serious problem that confronted scientists in this country was

whether the infected troops, coming from the endemic areas such as China, Japan, Egypt and other parts of Africa, stationed in this country or the Indian troops arrived back in this country after being infected in the endemic areas during and a little after the last two Great Wars, would act as a source of infecting the local molluscs and would thus menace the human population in this country. Soon after the first Great War this problem was critically examined by Sewell, Kemp & Graveley and Soparkar. Sewell (1919) acting mainly on the basis that since the species of molluscs which serve as intermediaries of *S. hæmatobium, S. mansoni* or *S. japonicum* do not occur in India, endemic human schistosomiasis is not possible to establish in this country. Kemp & Graveley (1919) tried experiments to infect potential molluscan hosts with the miracidia of *S. hæmatobium*. *Melania tuberculata, M. variabilis, M. lineata, Amnicola orcula, Bithynia sp., Vivipara bengalensis, Pachylubra globosa, P. carinata, Limnæa amygdalum, L. ovalis, L. succinea and Indoplanorbis exustus,* collected near Hyderabad and Secunderabad, were used by them in their experiments. All these molluscs proved refractory to the infection. Soparkar (1919), after discussing the pros and cons of the question, concludes with the remarks that the question whether human bilharziasis is likely to spread in India cannot, in the present state of our knowledge, be answered with any degree of certainty either in the affirmative or in the negative. This problem was re-examined by Mukerji, Bhaduri and Narain during the second Great War. In May 1944 a large body of West African troops was stationed in Ranchi area. Examination of urine and fæces of 22,317 troops revealed that 2, 061 were passing ova of *S. hæmatobium* and 38 individuals those of *S. mansoni*. *Indoplanorbis exustus, Acrostoma variabile, Limnæa luteola, Melanoides tuberculatus,* and *Vivipara bengalensis,* collected from the Ranchi area, were subjected to the artificial infection with the miracidia of *S. hæmatobium* but with negative results. The joint authors later tried to infect eight species of molluscs collected in Calcutta with the miracidia of *S. hæmatobium* and *S. mansoni*, but none of the molluscs caught the infection with either of the two species of schistosomes. Only in two instances was it observed that the miracidia of *S. hæmatobium* attached themselves to *Melanoides* and *Indoplanorbis* but after a short interval detached themselves again.

Although the extensive experiments of Kemp & Gravely and those of Mukerji et al., in three different localities in India, proved of a negative character, mello (1936) published some data regarding his attempts to infect some fresh-water molluscs in Portugese India with the cercariæ of *S. hæmatobium* and the results of his observations are very significant. In *Limnæa luteola* var. *pinguis* Dohrn he observed that miracidial attraction was very active and was often followed by penetration. He also encountered a natural case of the infection of *Melanoides* with furcocercous cercariæ which were indistinguishable from those of *S. hæmatobium*. His observations therefore offer a clue to explaining the sporadic occurence of the cases of bilharziasis in this country. This need not, however alarm us for the clinical, epidemiological and experimental data, obtained so far, do not warrant the conclusion that urinary bilharziasis may become endemic in India.

Schistosoma dermatitis in man.

Cort (1928) was the first to demonstrate that non-human schistosome cercaria produces the "Swimmer's itch'. The author encountered recently similar condition in men bathing in some of the tanks in the Mysore

State. He had engaged three men to collect snails from two tanks. They were wading through knee-deep water for about two hours. After they came out of the water they complained of itching sensation in the legs and started scratching them. Very soon their entire legs and part of their arms were covered with numerous papules. The condition grew more distressing after about six hours, when we had to offer them relief by the application of a concentrated solution of magnesium sulphate. Examination of the snails from the tanks revealed the presence of two species of furcocercous cercariae. Attempts are being made to identify these species of cercariae. The possibility of the existence of such a condition in this country was already forestalled by the author (Bhalerao, 1938).

Control and conclusion.

It will be realised from the foregoing account that schistosomiasis, particularly in domestic animals, is a very serious condition and brings about considerable monetary loss to [illegible] in this country. Strenuous efforts should therefore be made to control this condition by the known effective methods such as the treatment of affected animals, destruction of snails by mechanical, biological and [illegible] means and by the treatment and proper disposal of the [illegible]. Such measures will not only eliminate [illegible] but also exterminate other fluke diseases, both of men and animals, existing in this country.

References.

Andreasen, A T. & Suri, H.L. (1945), *Ind. Med. Gaz.*, *80*, 93-94.

Ayyar, K. V. (1925), *Mem. Dept. Agri. Ind, Vet. Ser.*, *3*, 6.

Baldrey, F. S. H. (1906), *J. Trop. Vet. Sci.*, *1*, 387-395.

Bhalerao, G. D (1931), *Ind. J. Vet Sci.*, *2*, 338-356, (1934), *Ibid*, *4*, 148-151, (1937), Skrjabin Jubilee Volume, Moscow, 47-51, (1938), *Proc Ind Sci Congr*, *25* 39, (1943), *Ibid*, *30*, 88, (1947), Presidential Address, Sec. Zool & Ent., *Ibid.*, 1-20.

Bomford, G. (1886), *Sci. Mem. Officers, India*, Pt. *2*, 53-55.

Chandler, A. C. (1926), *Ind J. Med. Res.*, *14*, 1779-183.

Cobbold, T. S. (1882). Trans. Med.—Chir. Soc., 1882, Nov. 14.

Cort, W. W. (1928), *Science*, 68, 388.

Datta, S. C. A. (1932), *Ind J Vet. Sci*, 2, 131-140, (1933), *Ibid.*, *3*, 217-236.

Fairley, N. H. (1925), *J. Path Bact*, *28*, 591-607, (1923), *Arch. f. Schiffs—u. Troppen- Hyg.*, *30*, 372-382, (1926), *Trans. R. Soc. Trop. Med. & Hyg*, *20*, 236-273, (1927), *Ind, J. Med. Res.*, *14*, 685-700.

——— & Jasudasan, F. (1927), *Ind. J. Med. Res.*, *14*, 685-700, (1927), *Ibid*, *14*, 701-706, (1930), *Ind. Med. Res. Mem.*, *17*, 1-10, (1930), *Ibid.*, *17*, 11-15, (1930), *Ibid.*, 17, 73-143.

——— & Mackie, F. P. (1925), Far East. Assoc. Trop. Med. 6th biennial Congr., Tokyo, *1*, 423-447, (1930), *Ind. Med. Res. Mem.*, *17*, 17-39.

——— Mackie, F. P. & Jasudasan, F. (1930), *Ibid.*, *17*, 53-69, (1930), *Ibid.*, 17, 61--68.

Harkness, A. H. (1922), *Br. Med. J.*, *1*, 475.

Hooton, A. (1914), *Ind. Med. Gaz.*, *49*, 188.

Kemp, S. & Gravely, F. H. (1919), *Ind. J. Med. Res.*, *7*, 251-264.

Leese, A. S. (1911), *J. Trop. Vet. Sci.*, 6, 262-267.

Liston, G & Soparkar, M. B. (1918), *Ind. J. Med. Res.*, *5*, 567-569.

Mallani, P. G. (1932), *Vet, Rec.*, *12*, 416, (1933), *Proc. Ind. Sci. Congr.* *28*, 383, (1933), *Ind. Vet. J.*, *10*, 257-277.

Mello, I. F. de (1936), *Proc. Ind. Acad. Sci.*, *3*, 107-114.

Montgomery, R. E. (1906), *J. Trop. Vet. Sci*, *1*, 15-36,; 138-174.

Mudaliar, S. V. & Ramanujachari, G. (1945), *Ind. Vet. J.*, *22*, 1-3.

Powell, A. (1903), *Br. Med. J.*, *1*, 490.

Price, E. (1929), *Proce. U. S. Nat. Mus*, *75*, 1-39.

Rao, M. A. N. (1933), *Ind. J. Vet. Sci.*, *3*, 29-38; 160-162. (1934), *Ibid.*, 1-28, (1937), *Ibid.* *7*. 100-112.

— & Ayyar, R. S. P. (1933), *Ind. J. Vet. Sci*, *3*, 321-324.

— — & Ayyar, R. S. (1935), *Ibid.*, *5*, 23-27.

Sewell, E. P. (1904), *J. R. Army Med. Corps*, *2*, 346.

Sewell, R. B. S. (1919), *Rec. Ind. Mus*, *16*, 125-129 (1919), *Ind. Med Gaz.*, *54*, 252-253 (1922), *Ind. J. Med. Res.* Suppl. No. 3, 370.

Soparkar, M. B. (1920), *Ind. J. Med. Res.*, *8*, 207-213, (1921), *Ibid.*, *9*, 23-32.

Wardrop, D. (1906), *J. R. Army Med. Corps*, *6*.

SECTION OF BOTANY

PRESIDENT: DR. K. A. CHOWDHURY, M.B.E., D.Sc., F.N.I.

SOME ASPECTS OF PURE AND APPLIED WOOD ANATOMY

(*Delivered on January 6, 1948*)

INTRODUCTION.

For the last eighty years, considerable research has been done to understand the anatomy of plants. Wood anatomy, which is but a branch of plant anatomy, did not receive attention even for such a long time. Research on wood anatomy has been carried out for only fifty years. Earlier workers in plant anatomy as well as wood anatomy were not aware of the exact nature of the material they were handling and recorded anatomical structure in such a way as to bring confusion in recorded observation. To start with anatomical structure of herbarium material and immature parts of plants mainly constituted the basic knowledge on the subject. But research carried out during recent years has revealed that wood formed during the youthful growth of a tree is different from that formed during its adult life. In other words, anatomical structure of young trees, small branches and twigs cannot be relied upon for a systematic classification of their mature woods It is, therefore, no wonder that the botanists in general were confused, and considerable doubt was created in their minds as to the value of wood anatomy for systematic classification of plants. However, pioneer work by Grew, Malphighi, Von Mohl, Nageli, Th. Hartig, Sanio, De Bary, Van Tieghem, Jeffrey and others made considerable contribution to our understanding of wood anatomy.

In 1930, at the International Botanical Congress, the idea of having an International Association of Wood Anatomists originated. The Association, which was actually formed in 1931, gave the anatomists a common ground for meeting and discussing their problems. Exchange of ideas and materials amongst its members has greatly facilitated research work in different parts of the world and has been responsible for the present state of our knowledge. In fact, "One World" theory of Wendell Wilkie has worked out very well in this Association. Credit for this success goes again to another American, the late Professor S. J. Record of the Yale University, U. S. A.

India owes a great debt to the late Mr. J. S. Gamble, F.R.S. for his book on "The Manual of Indian Timbers" (34). In spite of his other duties as a forest officer, this indefatigable worker found time to make a general survey of the important timbers of India at a time when little was known about the tropical woods., For years it remained the standard reference book on Indian timbers and to some extent it still is. Credit for up-to-date information on some Indian timbers goes to Dr. H. P. Brown of Syracuse University, U. S. A. He with Sir R. S. Pearson published in 1932 in two volumes "The commercial timbers of India" (43). At

present an attempt is being made at Dehra Dun to revise Gamble's "Manual of Indian timbers" and to bring it up-to-date. Work on some of the families is now ready for the press. It is the intention to publish this work in several volumes.

I. PURE WOOD ANATOMY.

Wood anatomy has two distinct aspects. One aspect is to study and interpret the anatomical structure of woods with a view to classifying them into different groups and sub-groups. To get a clear idea of the anatomy of wood, it is often necessary to know the different stages in the formation of wood in a tree. The other aspect of wood anatomy is to use the knowledge thus obtained in the utilization of timber resources of the country. It will, therefore, be seen that fundamental knowledge in wood anatomy is a pre-requisite for any attempt at efficient timber utilization.

Growth in Trees.

Tree-growth has been a subject for investigation for many years in temperate countries. Two types of growth are recognised; the extension growth or height growth and the radial growth. For a period of about eighty years, the exact place of annual initation of radial growth and its spread throughout the tree have been a subject for controversy. One school holds the view that the renewal of growth begins annually in the youngest shoot and then spreads downwards to the main trunk. The other school is of opinion that the growth may take place in the large branches and stems while the buds are not open and the twigs do not show any growth activity. Quite recently, Priestley and his co-workers at Leeds (45, 46, 47), by using a new technique, have found out that "cambial activity commences in the opening buds and then spreads basipetally over the old wood of branches and trunks." They have also reported that in the ring-porous and non-porous (coniferous) trees, the radial growth spreads with such an extra-ordinary rapidity that it may be observed in the main trunk when the buds are not well open. But in the diffuse-porous trees they have noticed that the spread of radial growth is comparatively slow.

Now, about a year or so before Priestley started on this investigation, a similar research was being carried out in India on some forest trees with the help of a different technique. Priestley's important discovery on the inception of cambial activity was immediately taken up by me for confirmation on tropical trees. By using my own method (7) as well as Priestley's, it has been possible not only to confirm his original observations but also to throw some light on certain points raised by him (7, 8, 9). Results of the studies on more than a dozen trees located in different parts of India, are summarized below:—

The cambial activity at first begins in certain young twigs in very narrow patches (not all round) just below the buds which are partly or fully opened and spreads downwards through the large branches towards the base of the tree. A point to note here is that all twigs do not start radial growth at the same time. This annual process is a slow one and usually takes some weeks to get going in all twigs and branches. At the earliest stage, the activity is mainly confined to the awakening of the cells of the cambial zones in the narrow patches and there are many gaps in the cambium of the main stem and branches, where no growth activity can be noticed. But later on these narrow patches extend sideways along the cambium and

join one another. It is then that the radial growth activity all over the cambium vigorously begins. This sequence is followed in all trees whether they are non-porous or ring-porous or diffuse-porous. In India, the spread of cambial activity is usually faster in the non-porous and ring-porous than in the diffuse-porous trees. There is, therefore, a general agreement with Priestley's observations on trees of temperate countries. But here mention must be made of some ring-porous trees of tropical India, which show the spread of cambial activity as slow as it is found in the diffuse-porous trees. Moreover, it appears that the speed at which the cambial activity spreads from the crown to the main stem of the ring-porous trees is dependent on the duration of seasonal activity. When, due to local conditions, the period of radial growth is long, say 6 to 8 months, the cambial activity spreads slowly. But when the radial growth activity lasts for only a few months, the spread of cambial awakening is fast (9).

These findings at Leeds and Dehra Dun go a long way to explain the reason for controversy over the awakening of cambial activity in the different parts of tree. It is now quite clear how some workers have got the impression that the radial growth may take place in the main stem when the buds are not open and the twigs do not show any growth activity. We have noticed in India that at the renewal of radial growth activity in the main stem, some buds are open while others still remain dormant. If any worker happens to notice most of the buds dormant but finds radial growth in the material he has collected from the main stem, he will naturally draw the conclusion that the radial growth in the stem is independent of that in the twig.. But we now know that this is a wrong impression which is due to the defect in taking out the samples for study.

Of all the local climatic factors, temperature seems to have the greatest influence on the initiation of cambial activity (9). The radial growth once started continues for sometime unless there is some serious disturbance in the normal physiology of the tree. The cessation of growth comes later in the season. The local factors responsible for it are not at present clearly understood. In temperate climate, low temperature has been said to be responsible for the cessation of radial growth. But in India this does not seem to be the case. For, it has been found out that the same species growing in different localities ceases to grow at different temperatures (9).

The height growth of trees has been studied by some foresters and others. The data collected in temperate region do not give us a complete picture of this phenomenon. Nor is it at present possible to clearly understand the factors which govern the commencement and the progress of this growth. In the tropics this study appears to be somewhat more complicated. Here, some trees show elongation of shoots regularly every few months, while others have more or less a continuous growth throughout the active season. There are also still other trees in which each big branch shows extension growth at different time of the year, almost behaving like an individual tree. In view of these, considerable research has yet to be done to clearly understand the height growth of Indian trees.

In this connection, Priestley has reported renewal of cambial activity in both ring-porous and diffuse-porous trees along with the extension growth of twigs. But in India, the height growth in these two groups of trees precedes the radial growth by 2-3 months. The primary growth has been found to be responsible for the extension of twig at the early period. The cambium cells in the newly formed twigs are swollen and fully developed

at that time but do not start secondary growth till much later in the season (23).

Classification of Woods.

The all important branch of botany is the classification of plants. The systematist classifies plants based on their external morphology and the anatomist studies the internal morphology of plants, which have already been classified by the systematist. It will, therefore, be seen that the anatomist is dependent on the systematist for the classification and naming of the material on which he is to work. Occasionally, systamatists have sought and made use of the aid of the anatomists to solve some difficult classification. For, when the study of external morphology does not allow a definite classification, knowledge of internal morphology may help in making the final decision. In 1883, Rodlkofer prophesied "The next hundred years will be devoted to the anatomical method" (51), but the botanical records of the last sixty years do not show much co-operation between the systematist and the anatomist. Each has been going on his own way, so to say. But recently, some systematists have expressed the view that all is not well with the method of classification that is being used by them, and that the findings and opinions of research workers in other branches of botany may be helpful in putting matters right for the systematists. In view of this, I hope that some of the problems of classification of woods reported here will be of interest to the systematist. In addition, it is my intention to indicate where co-operation of not only of systematists and anatomists but also of workers in other branches of botany and other branches of science is likely to be profitable to all concerned.

Upto 1930, anatomical investigation of wood was not based on any standard material. Nor were there in existence many standard terms for recording observations. The results were very depressing for, more work usually brought in more confusion. But with the formation of I. A. W. A., considerable progress has been made in these two respects. Work of Rendle and Clarke (48, 49) has greatly helped all wood anatomists to understand what standard material would be necessary to obtain reliable results. On the other hand, Chalk and Chattaway (2) have added considerably to our knowledge of wood anatomy by interpreting the size of cells in their formative stages. Lastly, the committee on nomenclature appointed by the I. A. W. A. (27), have standardized the terms used for describing woods. Based on the these works, considerable progress has been made in wood anatomy and the results are very encouraging. It can now be said that the taxonomic classification of woody plants is in general agreement with the anatomical structure of their woods. There is a great deal of similarity in anatomical details of the timbers that belong to a family. In fact, woods of some families show so much anatomical likeness that they can be recognised without the help of a compound microscope, for instance, *Anonaceæ*, *Dipterocarpaceæ*, *Rutaceæ*, *Sapotaceæ*, *Ebenaceæ* and *Lauraceæ*. Again, in *Apocynaceæ* and *Leguminosæ*, a great majority of the woods show similarity to such an extent that it is not so difficult to recognise most of the timbers belonging to these families. Lastly, there are other families which show a great variation in their gross anatomical structure. Classification of woods of these families though apparently difficult is not actually so; for, often it is possible to classify them under different families by studying their minute anatomical structure.

Now coming to further grouping in a family, it may be said that generic characters are mostly well defined. As a rule, different species in a genus

show more or less a homogeneous structure. This does not, however, mean that the characters used for separating different genera are the same in every family. Certain characters or combination of characters may be found useful for distinguishing the genera within one family but those very characters may not be useful in another family. An analysis of all the characters is usually necessary before an attempt can be made to separate the genera. Here, it may be pointed out that some overlapping of generic characters is not unknown to the anatomists, such as can be found in *Dalbergia* and *Pterocarpus* of *Leguminosæ* and *Terminalia* and *Anogeissus* of *Combretaceæ* and in others. But this does not offer much difficulty for classification, provided the limit of overlapping is clearly understood.

We now come to the species. It must be said at the outset that our knowledge of the anatomy of taxonomist's species is very limited. Differentiation of the species is at present possible only in exceptional cases such as, when there are a few species in a genus, or when a species constantly shows a line of specialization not present in the other species of the same genus. In the genera with a large number of species, it is not possible to separate all of them. What can, however, be done sometime is to lump different species into 2-3 groups within a genus, for instances, *Shorea*, *Morus*, *Quercus* and *Pinus*. It will be realized that the characters which can be used at this stage of classification are usually of minor nature. The size and frequency of these characters are the only bases that can be used profitably. Attempts (48, 49) to find out the significance of anatomical variation within a species have also been made. Statistically analysed data give us something to work with but the method devised is not yet perfect. At present different characters or criteria can be analysed singly and their significance determined. But in a case where half the number of characters shows significance and the other half does not, no definite conclusion can be drawn. In order to meet the special requirement of the wood anatomists, the statisticians will have to evolve some formulæ. I, therefore, take this opportunity to appeal to them to give us help immediately, otherwise we cannot make further progress in our understanding of species. Below the rank of species little anatomical work has been done. Usually varieties and hybrids (4, 39) have very similar anatomical structure and at the present state of our knowledge in wood anatomy, observations made on these woods are not possible to be used profitably for classification.

So far I have given you some idea of the classification of wood *vis-a-vis* classification by the taxonomists. Now I intend to tell you something about the characters or criteria that are used for the classification of woods. As a rule, all macroscopic and microscopic anatomy of a wood is taken into consideration for its final classification. In selecting these characters, anatomists have to judge what characters are variable and what are not variable. This is a difficult problem and can be solved only with long experience and observation. The present list of characters under these two heads are naturally tentative. As a result of further research, some of these characters may have to be shifted from their present position and some new characters are likely to be added to the lists.

Amongst the constant or non-plastic characters, resin canals, gum ducts, oil cells and included-phloem, are visible on the end surface of the wood. Resin canals and gum ducts are known to develop normally in some woods, while in others as a result of some injury. Although it is often possible to distinguish them by their distribution, yet the relation between the normal

and the traumatic is not clearly understood at present. The presence or absence of resin canals and gum ducts, however, gives indications of relationship to certain families and genera and is, therefore, used with caution for general classification. Now, the vertical oil cells are characteristics of certain families such as *Lauraceæ* and *Rutaceæ*, while the horizontal oil cells are also found in certain genera *e g*, *Magnolia* and others. Occurrence of included phloem has been recorded in certain genera and species, and this character being rare in woody dicotyledons, is often used with advantage for the classification of timber. Moreover, vessel distributions known as pore chain and pore cluster are conservative characters of certain families and genera, *e g*, *Calophyllum, Mesua, Morus* etc., and can, therefore, be used with advantage for speedy classification of these woods.

The remaining constant characters are visible only on the longitudinal surface of the wood. These are, perforation plates of vessels, spiral thickenings in pores, pits and rays. The simple perforation plate is found in the majority of the porous woods, while a few are known to have scalariform, reticulate and ephedroid types of plate. The occurrence of the latter types is, therefore, of great help in general classification. Spiral thickenings of vessels are not common features of secondary wood Their occurence is, therefore, of considerable help in making a speedy grouping of timbers.

The nature of pits, their size, shape and distribution have so far proved to give a reliable clue to the families and genera. But mention here must be made of the careful laboratory technique that is necessary to obtain useful data on this character. Bad technique in the preparation of microscope slide may give a wrong view of the real nature of the pits and ultimately bring in confusion in the systematic classification of woods.

It is well known that the rays vary to a great extent in their height and width depending on the part of the tree they occur. It is also known that the rays placed adjacent to vessels and parenchyma cells show considerable variation in their size and shape. But when the rays are embedded in fibrous tissue, they seem to show a constancy in their shape and also in the shape of the component cells they are made up of. In fact, the shape and arrangement of the component cells of this particular type of rays seldom seem to vary within a genus. This character I have used for many years and found very helpful for the classification of woods Lastly, the ripple marks formed by the rays are not less important for quick classification of timbers of broad-leaved trees.

Now, the variable or plastic characters are the distribution of vessels, tracheids, fibres and parenchyma cells that can be seen on the end surface of the wood. Based on the size and distribution of the vessels within a growth ring, woods have been classified as ring-porous and diffuse-porous. As a rule, ring-porous timbers are only a few in number in comparison with the diffuse-porous timbers and even these few ring-porous timbers are mostly confined to the temperate region. Rigour of growth condition prevalent in temperate countries, has been said to be responsible for the formation of ring-porous woods. In fact, Huber (36) has proved it to be so by his researches. He has found out that the rate of conduction of sap in the ring-porous trees is, on the average, 10 times as fast as that found in the diffuse-porous trees. All these mean that ring-porosity is the result of environmental conditions prevalent in certain localities. In this connection our (18) observations in India are of some interest. We have found out a remarkable variation in the pore-zone of some ring-porous trees of tropical

India. Here, there are some trees which are sometime ring-porous, sometime semi-ring-porous and sometime even diffuse-porous. In spite of so much variation in this character, I have found it to be of considerable help in the classification of woods, because of the fact that the limits of its variation are now well understood.

There is a great deal of variation in the size, shape and the wall-thickness of tracheids and fibres within a family, a genus, a species and even in the different parts of the same trees. But nevertheless, the characteristic pits on the wall of tracheids and rays of conifers give a reliable clue to different genera. Moreover, the presence of tracheids in the dicotyledonous woods is a helpful character for classification. Septate fibre, though once considered to be a constant character, does no longer appear to be so. Frequency of its occurrence in certain families and genera requires further clarification before it can be reliably used for classification. Mucilaginous fibre because of its erratic development appears to have no significance for grouping of woods.

The classification of parenchyma cells is at present far from perfect. In fact, the different terms suggested by the "committee on nomenclature" (27) leave much to be desired. For example, the classification of the terms paratracheal and metatracheal though theoretically simple to understand, yet in practice is often very difficult to apply. For, it is not quite clear what the limits of their variation are and when one type merges into another. Careful and painstaking observations will be required to unravel the complicated distribution of these two types of parenchyma cells. Some suggestions have, however, been recently put forward on the possible classification of a sub-group of metatracheal or apotracheal parenchyma (20). But this is only a beginning. Co-operation of many workers will be necessary to handle an enormous problem like this. As far as terminal parenchyma cells are concerned, they are not difficult to determine and classify. Careful observation and strict adherence to nomenclature is likely to remove all confusion (6). Lastly, the initial type since its discovery in 1934 (5) has been worked out in considerable detail and may be summarized here. When a wood is ring-porous, the initial parenchyma cells fill up, at least, the inner side of the pore-zone, if not the whole of it, *e.g.*, *Morus alba* Linn., *Ulmus wallichiana* Planchou, and *Quercus serrata* Thunb. And when the timbers are semi-ring-porous, initial parenchyma cells confine themselves to a row or two on the inner side of the growth ring, *e.g*, *Cedrela toona* Roxb., *Juglans regia* Linn., *Diospyros virginiana* L. and *Lagerstroemia flos-reginæ* Retz. The initial parenchyma is also found in some diffuse-porous woods *e.g.*, *Terminalia tomentosa* W. & A. (5, 6), *Dalbergia sisso* Roxb. (8), *Salix matsudana* Koidz. (3) and *Entandrophragma macrophyllum* A. Chev. (37). The relation between initial parenchyma and ring-porosity has been fully discussed in the study of *Gmelina arborea* Linn. (18). We have, therefore, now a complete picture of the possible variation that is found in the initial parenchyma cells.

The anatomical characters enumerated above though in some cases not clearly understood at present yet all of them taken together lead the anatomists to family and genus and even occasionally to species. In practice, it has been possible at Dehra Dun to trace some timbers from unknown countries to their families and genera. When the countries of supposed origin were referred to, our classification was found to be correct. I have no doubt that there are many other wood anatomy laboratories, which are

doing similar type of work. All this can be done, because every anatomist, based on his experience, has got some idea of the variation he is likely to come across in plastic characters. At present the extreme limit of variation in all plastic characters is not known and it is here that our main line of research activities should lie. Due to obvious difficulties in obtaining wood samples of a genus or a species from throughout its distribution, work on this line by anatomists has been rather limited. To me it seems that the days of general survey of family or families are now over. Intensive study of a genus or a species throughout its distribution is likely to give us a clear and complete idea of the variation in plastic characters and thus ultimately make classification more easy than it is to-day.

Lastly, I come to the classification of wood in relation to phylogeny. Jeffrey was one of the pioneers to make a phylogenetic study of woods. He advanced some hypotheses on the lines prevalent amongst the biologists of his time (38). The validity of those hypotheses has, however, been questioned by some subsequent workers. On the other hand, Bailey and Tupper (1) studied the length of tracheary elements in Cryptogams, Gymnosperms and Angiosperms, and established the fact that reduction in the length is an index of their specialization. This work was followed by Frost (31, 32, 33), who established further lines of specialization in various minute characters of the tracheary elements. These investigations have proved how the anatomists, without any pre-conceived ideas about evolution formulated by taxonomist, can produce reliable evidence regarding the line of specialization in the different groups of the Angiosperms. But the result of such an important research can be mis-understood and mis-interpreted, For instance, Kribs (40,41), Tippo (52) and others have investigated the lines of specialization in wood elements other than those of tracheal origin, taking it for granted that all the elements of wood follow the same lines of specialization. It is difficult to appreciate the usefulness of such investigations, which raise controversial points like linear, divergent and convergent lines of evolution. Turrill (53) in his excellent survey on "Taxonomy and Phylogeny" has shown the exact position of our knowledge on this very complicated subject. To my mind, anatomists' attempt at phylogeny at this stage is a bit too early. Data collected for the last five decades leave many gaps in our knowledge in wood anatomy, and to give a phylogenetic interpretation to this incomplete knowledge of ours is at present hardly justified.

II. APPLIED WOOD ANATOMY

So far I have spoken of pure wood anatomy and now I shall try and give you some idea of how this fundamental knowledge has been or is being used for national development. Strange though it may seem it is a fact that the two world wars have been greatly responsible for the speedy advancement in applied wood anatomy. The reason is that, during a war, when a country has restricted communication with the outside world, efficient and economic use of its raw material becomes imperative. It is only then that the fighting forces approach the wood anatomists for advice as to how they can make the best use of the timber resources that are available in the country.

Three main steps are usually taken during a war. Firstly, restriction is put on the use of important timbers which have limited supply. It is only by this means that a country can obtain the maximum service from its total timber resources. In India, during the last war indiscriminate use of teak (*Tectona grandis* Linn. f.) and walnut (*Juglans regia* Linn.) was stopped

and they were used only for the purposes for which no other timber would have served. Secondly, new or commercially unknown timbers are brought into the market. This raises some difficulties, for very little information on the physical properties and working qualities of these new timbers is usually available. But at this stage wood anatomists with the knowledge of anatomical structure can be of considerable help in roughly classifying these timbers for different uses (21). Thirdly, an attempt is made to find out substitutes for imported timbers. Here the anatomists have to look for those very anatomical characters of woods, which are responsible for their suitability for specific purposes. In India considerable work was done during the last war. To cite a few cases, Indian spruce (*Picea morinda* Link) and silver fir (*Abies pindrow* Spach) were found to be as good as sitka spruce (*Picea sitchensis* Carr.) of U.S.A. and Canada for making aircrafts (24). Indian red cutch (*Acacia sundra* D. C.) proved to be a good substitute for Lignum vitae (*Guaiacum officinale* Linn.) of South America, used for propeller tail shaft bearing of ship (14, 16). *Anogeissus* sp. gave a good service as helves and tool handles for which imported ash (*Fraxinus* sp.) and hickory (*Hicoria* sp.) were used before the war. *Vateria indica* Linn. proved to be an excellent substitute for imported oars for sea-going boats.

Specific Gravity, Physical Properties and Anatomical Structure of Timber.

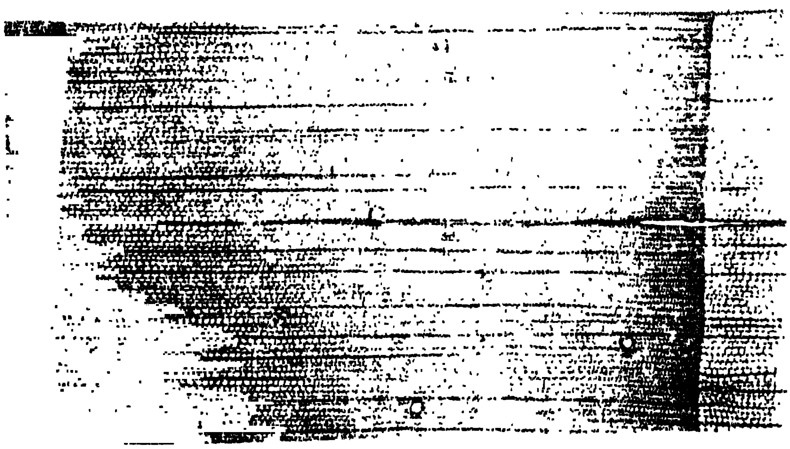
Of all the physical properties of wood, its density or its weight per cubic foot, at a certain moisture content, has been found to be the best indicator of its various qualities. We all know that a light wood is weak and heavy wood is strong. This is because the cell-wall material in a unit volume of light weight wood is much less than that can be found in a similar volume of heavy wood. A great mass naturally resists external forces much more than a small mass. Moreover, there is variation not only in the weight of different timbers but also in the timber from different parts of the same tree. Wood from the root is the lightest; then comes the main bole and the heaviest of all is the branch wood (29, 30). There are physiological and mechanical reasons for this.

Another point of considerable importance from practical point of view is that the wood produced in the main bole during the early life of a tree is usually of different structure from that formed later in life. As a rule, the 'juvenile wood' is thin walled and lighter and weaker than the mature wood. That is why the specifications for certain important uses restrict the use of wood from the centre of the log and near about it.

Again, the weight of wood varies along with variation in the rate of growth. Of the three groups of timbers recognised by the wood anatomists, the non-porous and the ring-porous woods have shown some definite correlation with the rate of growth. In these timbers there are usually two definite layers within a growth ring, called earlywood and latewood. As a rule, the earlywood is lighter in weight and weaker in strength than the latewood. It will, therefore, be seen that the quantity of earlywood and latewood present in a unit volume of non-porous and ring-porous wood, will ultimately determine whether it is going to be weak or strong.

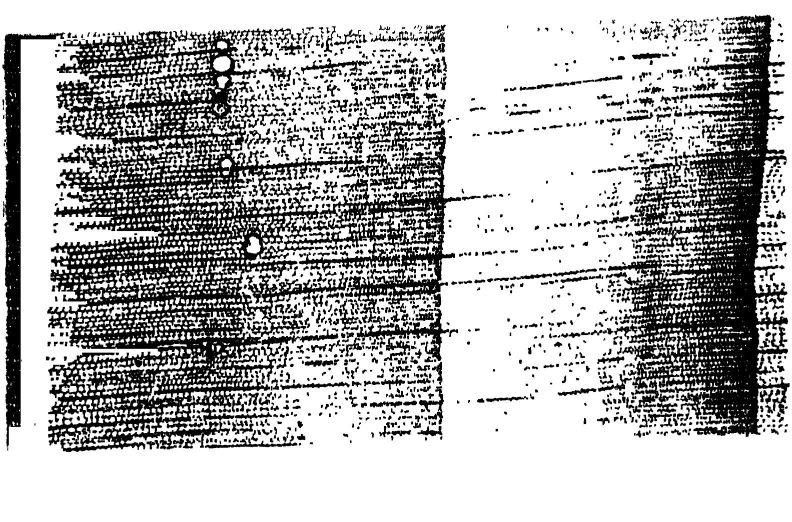
It has been known for a long time that slow grown non-porous woods are usually strong. The reason for this has been found to be that the volume of latewood, in this group of timbers, remains more or less constant irrespective of the width of the ring. The more is the number of growth rings per inch, the higher is the percentage of latewood and the stronger is the

timber. But experience has also shown that this is not always true. Some slow grown non-porous timbers are unexpectedly weak. Anatomical investigation of these timbers has revealed that the volume of latewood remains only constant upto a certain number of rings per inch and beyond that its volume also reduces along with the reduction in the width of the ring (Plate I, A, B & C). In Indian spruce (*Picea morinda* Link.) we have found out that the strongest timber is produced when the rings vary from 7-16 per inch and that the spruce wood with less than 7 and more than 16 rings is usually weak.



A

5 rings per in.



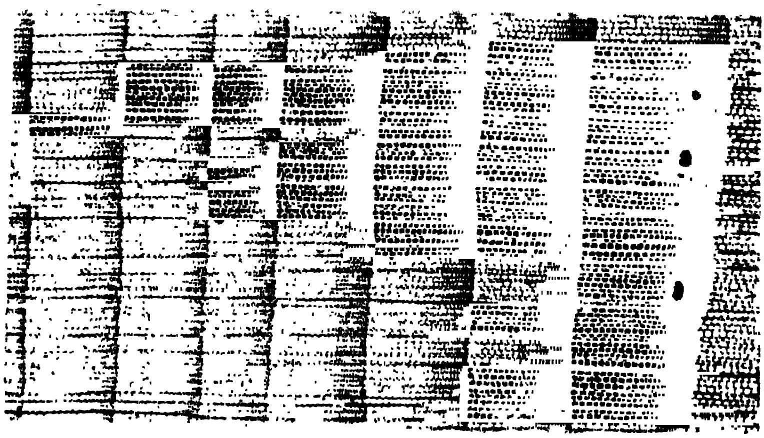
B

SPRUCE

Picea morinda Link.

(X. 20)

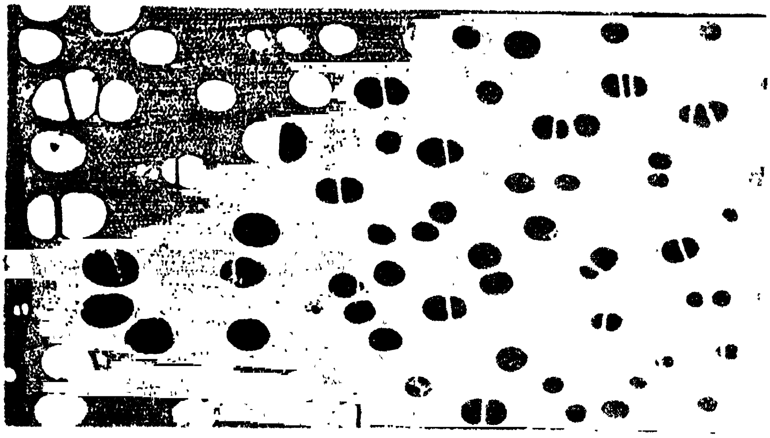
10 rings per in.



C

36 rings per in.

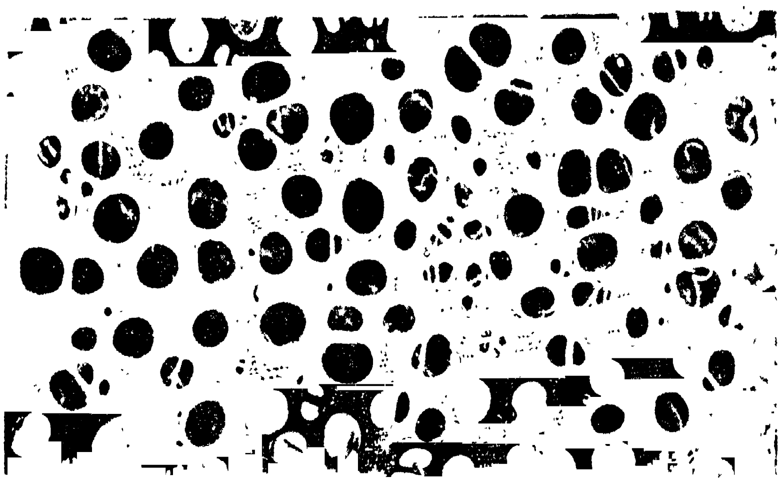
In the ring-porous timber, it is just the other way. The faster is the growth, the stronger is the timber. In this case, the volume of earlywood remains more or less constant irrespective of the width of the ring (Plate II, A, B & C). But once again we find that too fast grown ring-porous timbers are also weak. This is due to the fact that the cell wall of the latewood then becomes unusually thin at places and consequently the timber turns out weak (Plate III, A, B, C & D). In the ring-porous wood of teak (*Tectona grandis* Linn. f.), the strongest timber has so far been found to be with growth rings varying from 4-12 per inch. It is doubtful whether teak wood with less than 4 rings per inch will serve any purpose for which strength is considered to be the main criterion. On the other hand, it is a common experience that extremely slow grown teak plank will break under the pressure of fingers like a piece of biscuit.



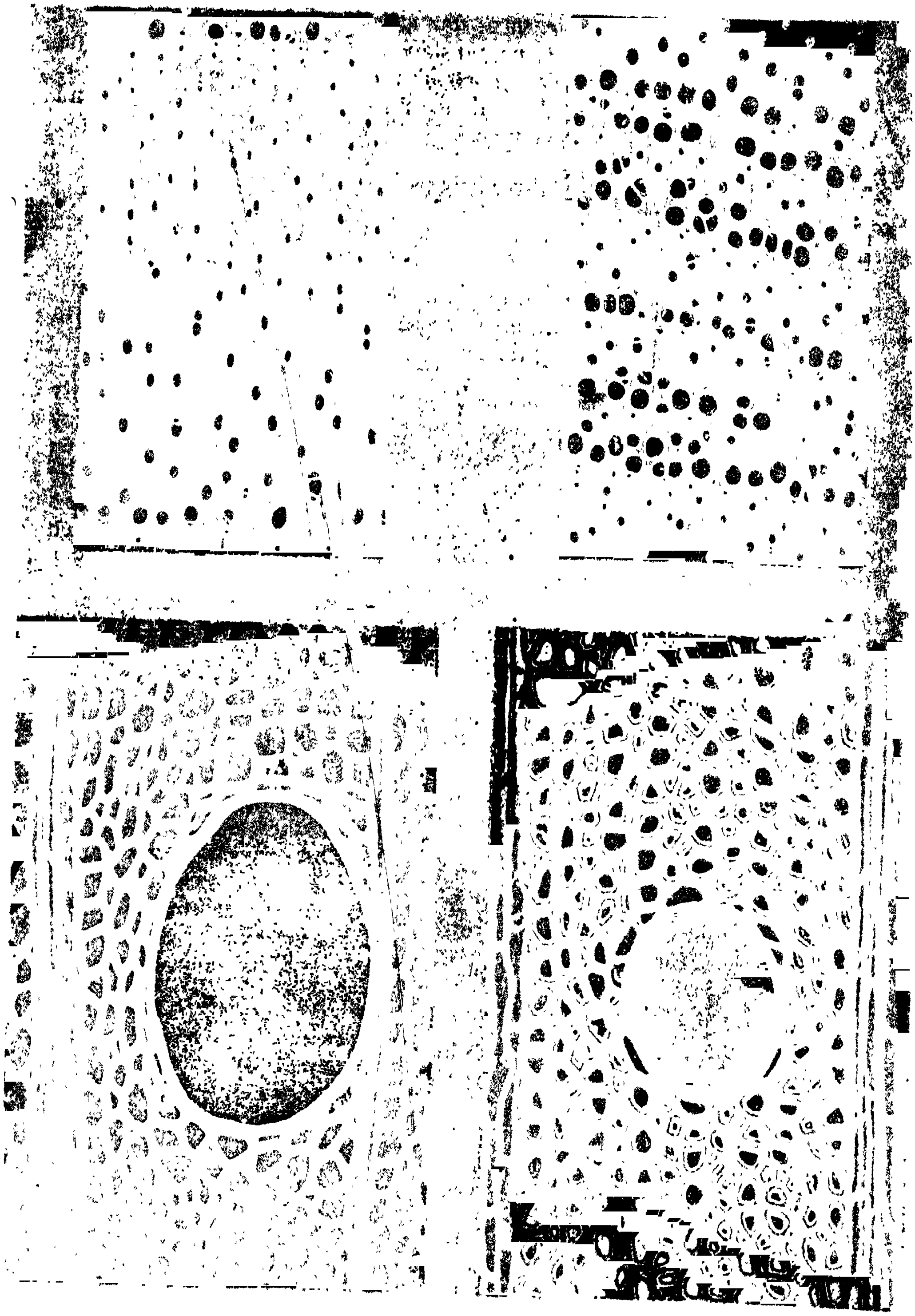
A

3 rings per in.

B
TEAK
Tectona grandis Linn.f.
(× . 20)
11 rings per in.



C
44 rings per in.



Now, in the third group of wood, namely diffuse-porous, the rate of growth may or may not have any relation with its strength. The growth rings are not always present in them nor can the earlywood and latewood be easily distinguished. In these circumstances, the weight of the wood and consequently its strength are determined by the size and distribution of the pores, thickness of the fibre-walls and the amount of parenchyma cells and rays that are present in a unit volume.

In summing up for all the three groups it may be said that too fast and too slow grown timbers are likely to be weak. The strongest timber is produced when the rate of growth is medium. Researches carried out so far have shown that each timber species reacts differently and produces timber of high strength at different rate of growth. It has, therefore, become necessary to investigate each different timber species and find out the rate of growth at which it will produce a strong timber.

Results of this research have enabled us not only to utilize efficiently the existing timber stock of our country but they have also shown us the way to produce the required quality of timber in our forest. For, it is now known that some control on the rate of growth of different timber trees is possible by proper management of forest. Considerable work on this problem has been done in U.S.A. (42) and a profitable line of co-operation between forestry and industry has begun.

I must now refer to some exceptions to the above rules. First of all let me consider the 'Compression wood' which is found in coniferous trees. The 'Compression wood' which is formed on the lower side of the leaning tree or a branch, may be as much as 40% heavier than the normal wood but is usually weaker in strength. Besides this, the 'Compression wood' is liable to higher longitudinal shrinkage than the normal wood and is, therefore, a source of trouble like twist and warp in converted timber. Intensive research by Pillow and others (44) has also brought out some more minute characteristics of the 'Compression wood' and it is now known that in contrast with the normal wood, the 'Compression wood' tracheids are short in length and circular in cross section with characteristic inter-cellular spaces. Chemically lignin content of 'Compression wood' is higher than that of the normal wood. Moreover, it is now possible for us, in many cases, to detect this type of defect in timber in the field and this is decidedly a step forward towards efficient utilization of timbers.

Somewhat similar type of formation takes place in the broadleaved tree and is known as 'tension wood'. As the name implies, the abnormal wood is confined to the upper side of the crooked branch or stem. The growth rings frequently show eccentricity with wider rings on the upper side. Microscopic examination has shown that fibres in the 'tension wood' often have gelatinous secondary wall. Physically 'tension wood' behaves differently from the normal wood as regards strength and seasoning properties (25, 26) and is, therefore, classified as a defect by the wood using industries.

In addition to these, the weight of wood may sometimes increase without corresponding increase in its strength. This happens when the extraneous deposits are unusually heavy. The explanation is quite simple. These deposits are lodged in different cell cavities and increase the weight of wood but the cell-wall material in a unit of volume remains unaltered and, therefore, there is no proportionate increase in the strength of the timber.

Amongst Indian timbers, teak (*Tectona grandis* Linn. f.) from some localities often shows this defect.

Water in Relation to Wood.

In commerce and industry wood is rarely used in green condition. The old practice is to let the wood dry under normal atmospheric conditions and this is naturally a slow process. For quick drying an artificially controlled chamber called seasoning-kiln is used. By either method moisture content can be brought down considerably, and often to a desired level. The behaviour of wood during the process of drying or seasoning depends to a great extent on its anatomical structure. As a rule, heavy timbers dry more slowly than light timbers. After timber has been seasoned and the moisture content has been brought down to the desired level, it is prone to absorb a certain quantity of moisture from the atmosphere in rainy season. At that time light timbers absorb moisture more rapidly than heavy timbers. Also the maximum moisture content of light timbers at a particular humidity is higher than that of the heavy timbers. All these are due to the difference in the cell wall material that is present in a unit volume of light and heavy timbers. Then there are some exceptions to this general rule. Amongst the timbers of same density some are easy to dry, *e.g.*, haldu (*Adina cordifolia* Hook. f.) and kuthan (*Hymenodictyon excelsum* Wall.) while others dry very slowly, *e.g.*, gamari (*Gmelina arborea* Linn.) and jhingan (*Lannea grandis* Engl.). Again, amongst slow drying timbers of same density some are liable to cracking, *e.g.*, bishopwood (*Bischofia javanica* Blume) and others form moisture pockets and lose shape, *e.g.*, gurjan (*Dipterocarpus* sp.) and *Bridelia retusa* Spreng. It is often possible to give an anatomical explanation for this exceptional behaviour of wood but not always. At present our knowledge of the seasoning properties of different tissues of wood is far from complete. There is still a great scope for research on this line and time might not be very far off when by studying the anatomical structure of wood it would be possible to predict its seasoning properties.

Water in the form of chemical solution also plays an important part in the industries which use wood as a raw material. In paper and rayon mills as well as in wood preservative plants, penetration of chemical liquid is a problem of considerable importance. But our knowledge of this subject is very limited. Except for the fact that a liquid penetrates quickest along the longitudinal direction of a cell, we know almost nothing more. Here is a line of co-operative research for the chemists, physicists and plant anatomists to be taken up. A successful completion of this research, I am sure, will considerably help efficient running of many industries.

Resin and Gum Tapping.

That some forest trees produce gum and resin, if an incision is made on their main stems and branches, was known to our forefathers. The methods at first applied by them for obtaining these products were varied, and often crude and destructive. With experience, they gradually came to know the type of incision which would give some good results. But to find out the best method of tapping, one must have a clear idea of the cells and tissues which are actually responsible for gum and resin production. Here plant anatomists can be of considerable help. By studying the plants from seedling to mature stage they may be able to devise suitable methods for collecting these products.

Some of the resin and gum producing trees have normal resin canals and gum ducts in their wood, while others produce these special cells as a result of some wound on their stem. Moreover, in the first group, when a wound is made the number of gum ducts or resin canals is likely to increase per unit volume. The part played by the cambial cells in enhancing the production of gums and resins must not also be overlooked. Exposing the bark, cambium and wood for the production of gum would, therefore, appear to be a necessary operation.

In India only a few trees are regularly tapped for resin and gum. Chir (*Pinus longifolia* Roxb.) in the North is well known for its resin production, and it is being tapped in such an efficient manner as to supply raw material for three factories now in existence. Next comes the karar (*Sterculia urens* Roxb.) growing in somewhat rocky and arid zones of Indian peninsula. The method of collecting gum from this tree is not yet well standardized but sufficient research has been done to stop the present destructive method and to suggest methods which will not upset the normal physiology of the tree. In addition to these, there are many others, such as *Acacia senegal* Willd, *Ailanthus excelsa* Roxb., *Pterocarpus marsupium* Roxb., *Vateria indica* Linn., *Canarium* sp. and *Shorea* sp. which are tapped for gums that are used locally. The methods of collection of gum from these trees are varied and are not in all cases based on the knowledge of their internal anatomy. There is, therefore, considerable room for research and improvement on their present method of tapping.

Identification of Wood.

The first step towards efficient utilization of the timber resources of a country, is to be able to identify the various timbers. After a timber has been identified, the user is in a position to decide whether it will serve the purpose for which he is going to use it. After all we know that all timbers are not similar nor can any one timber usefully serve for all purposes. Some timbers are good for helves and hammer handles, while others will do well for light furniture. There are still others which will give good service in house building. Such being the case, the importance of identifying timbers before they are actually used, cannot be over emphasised. This is especially so in a country like India, where we have got a very large number of timber species, many of which are available only in small quantities. As a result, there is a tendency not only to introduce new timbers into the market but also to pass on cheap timbers of poor quality under the names of better class timbers of proved reputation. I can cite innumerable cases of timber having been sold under false names. One example I still remember though it happened many years ago, because it was done cleverly and deliberately. A timber merchant sold to the Royal Engineers some sap wood of teak (*Tectona grandis* Linn. f.) under the name of heartwood of deodar (*Cedrus deodara* Loudon). These timbers undoubtedly have somewhat similar look and the timber merchant took advantage of it. But the sapwood of teak is easily perishable while the heartwood of deodar has a reputation for its durability. The timber bought by the Royal Engineers was utilized for making some boats which were used only on special occasions. After the boats had been used twice, they found out that there was something wrong and brought the case to our notice. But it was then too late for us to give any help and the boats had to be declared unserviceable and thrown away. During the last war, constructional works worth over a crore of rupees came to disaster due to the use of cheap and bad quality timber in the place of

good quality and reputable timbers specified in the contracts. To cite only 2 cases, I may mention here about the collapse of hospitals at Karachi and of air-raid shelters near Calcutta.

During the World War II, the Supply and Defence Departments of Government of India realized that the identification of timbers that they were handling was of considerable importance for efficiently conducting the war. Some 350 officers and others from these departments were sent to Dehra Dun to undergo a short course of training in the field identification of timbers. Some of these men on return to their departments trained others to carry out the work efficiently. Various guide books (10, 11, 12, 13, 15, 17, 22, 35) were also prepared by the Forest Research Institute to give help to these trained men. I think, I have now given you enough examples to show the usefulness of identification of timbers during peace and war.

In addition to the financial aspect of wood identification, there is a cultural aspect, for example the study of fossil woods. To know what trees were growing million years ago and if they are still in existence anywhere in this earth of ours is a piece of interesting information. The change of tree vegetation along with the change of climate interests many plant ecologists. The effect of the climatic changes on the anatomical structure of woody trees interests many anatomists and evolutionists. Lastly, the identification of fossil woods often helps the geologists in determining the strata of the deposit he is studying.

There is also another cultural aspect which has hardly been explored to its fullest capacity, namely the study of archæological wood. Archæological excavations uncover many wooden articles, which were used by our ancestors. Some of these may give us an idea of the climatic condition and vegetation prevalent at that time (28, 50), while others may indicate the commercial connection that those people maintained with the outside countries, both far and near. Lastly, the various wooden articles excavated give us an idea of the knowledge those ancestors of ours had of timber utilization (19).

To me it seems that an ancient country like India, with so many old monuments preserved, offers a great opportunity to our wood technicians. They can study the present condition of the timbers that were used for structural purposes. It is true that a complete record of their past history is not available in many cases and we cannot possibly draw definite conclusions. But based on whether these timbers have been used in an exposed or a protected position and how far the deterioration has progressed, we should be able to collect some valuable information, which could be intelligently used for drawing up plans for our future experiment and research.

In summing up I may point out that there is still a vast field of research in pure wood anatomy that remains unexplored. It is extremely doubtful whether the small band of wood anatomists now engaged in different parts of the world, will be able to finish all these problems within a reasonable time. Co-operation of the botanists working in universities will greatly expedite this work and I hope that they will now take a little more interest in wood anatomy than they have been doing so far. On the other hand, whatever little knowledge we have in pure wood anatomy, is not being fully utilized for practical purposes. I appeal to those who are responsible for our national development to put the wood-using industries on a sound foundation. Firstly, it is essential to know what timbers are suitable for different industries and then to use only those very timbers and no others.

Secondly, it is necessary to classify each timber into different grades based on its anatomical structure. After all it is not possible for any wood using industry to produce standard finished articles until and unless it uses standard raw materials.

REFERENCES

1. Bailey, I.W. and Tupper, W.W. (1918). Size variation in tracheary cells. *Proc. Amer. Acad. Sci.* 54.

2. Chalk, L. and Chattaway, M.M. (1934). Measuring the length of vessel members *Trop. Wood.* 40, 12.

3. Chang, Y. (1936). Private communication.

4. Chowdhury, K.A. (1931). Anatomical studies of the wood of a hybird larch. *Jour. For.* 29, 5.

5. ——— (1934). The so-called terminal parenchyma cells in the wood of *Terminalia tomentosa* W. & A. Nature, London, 133, 215.

6. ———(1936). Terminal and Initial parenchyma cells in the wood of *Terminalia tomentosa* W. & A. *New. Phytol.* 35, 4.

7. ———(1939). The formation of growth rings in Indian trees. Part I. *Ind. For. Rec.* II, 1.

8. ———(1940) The formation of growth rings in Indian trees. Part II. *Ind. For. Rec.* II, 2.

9. ———(1940). The formation of growth rings in Indian trees. Part. III. *Ind. For. Rec.* II, 3.

10. ———(1942). Part I. Hints on the identification of Indian timbers. *Ind For. Leafl.* 21.

11. ———(1942). Part II. Timbers for Helves and Tool handles. *Ind. For. Leafl.* 25.

12. ———(1943). Part III. Timbers for Motor Lorry Bodies. *Ind. For. Leafl.* 37.

13. ———(1943). Part VI. Timbers for Camp Furniture. *Ind. For. Leafl.* 51.

14. ———(1944). *Acacia catechu* var. *sundra.* (Red cutch, Lal Khair). *Ind. Forester.* 70, 9.

15. ———(1945). The Identification of Burma commercial timbers. *Ind. For. Rec.*, N. S., 3, 6.

16. ———(1945). Further information on Red cutch (*Acacia sundra*). A substitute for Lignum-vitae (*Guaiacum officinale*) *Ind. Forester.* 71, 11.

17. ———(1946). Regional keys for the identification of important timbers used in military areas of inspection. *Ind. For. Rec.*, N. S., 3, 7.

18. ———(1947). Initial parenchyma cells in dicotyledonous woods. *Nature,* London, 160, 609.

19. ———and Ghosh, S. S. (1946). Report on wood and fruit shells. Ancient India. *Bull. Archæol. Surv. Ind.*, No. 2.

20. Chowdhury, K. A. and Ghosh, S. S. (1946). On the anatomy of *Cynometroxylon indicum* Gen. Et. Sp. Nov. A fossil dicotyledonous wood from Nailalung,

Assam. *Proc. Nat. Inst. Sci. Ind.* 12, 8.

21. ———(1946). Some more commercial timbers of India. *Ind. For. Rec.* 4, 3.

22. ———and Tandan, K. N. (1943). Part V. Timbers for Gun and Rifle parts. *Ind. For. Leafl.* 50.

23. ———The relation between height and diameter growth in Indian forest trees, (unpublished).

24. ———and others. Anatomical study of Indian spruce and fir in relation to their suitability for aircraft. (unpublished).

25. Clarke, S. H. (1937). The Distribution, Structure and Properties of Tension Wood in Beech (*Fagus sylvatica*) *Forestry.* 11.

26. ———and Franklin, G. L. (1938). The Occurrence of Tension Wood in Ash (*Fraxinus excelsior*). *Dept. Sci. Ind. Res. For. Prod. Lab. Progress Report* 3, Part V.

27. Committee on Nomenclature (1933). Glossary of terms used in describing woods. *Trop.* Wood. 36.

28. Douglass, A. E. (1914). A method of estimating rainfall by the growth of trees. The climatic factor as illustrated in arid America, by E. Huntington, *Carn. Inst. Washington Publ.* 192: Ch. XI.

29. Fegel, A. (1941). Comparative anatomy and varying physical properties of trunk, branch, and root wood in certain North Eastern trees. New York State College *For. Tech. Bull.* 55.

30. Forsaith, C. C. (1926). The Technology of New York State timbers. New York State College *For. Tech. Publ.* 18.

31. Frost, F. H. (1930). Specialization in secondary xylem of dicotyledons. I. Origin of vessels. *Bot. Gaz.* 89.

32. ———(1930). Specialization in secondary xylem of dicotyledons. II. Evolution of end wall of vessel segment. *Bot. Gaz.* 90.

33. ———(1931). Specialization in secondary xylem of dicotyledons. III. Specialization of laterial wall of vessel segment. *Bot Gaz.* 91.

34. Gamble, J. S. (1922). The manual of Indian timbers.

35. Ghosh, S. S. (1943). Part IV. Timbers for Boxes and Packing cases. *Ind For. Leafl.* 46.

36. Huber, B. (1935). Die physiologische bedeutung der ring-und zerstreutporigkeit. *Dtsch. Bot. Ges.* 53, 8.

37. Hummel, F. C. (1946). The Formation of Growth Rings in *Entandrophragma macrophyllum* and *Khaya grandifoliola*, *Emp. For. Rev.* 25, 1.

38. Jeffrey, E. C. (1917). The anatomy of woody plants.

39. Johnson, L. P. V. (1942). Studies on the relation of Growth rate to wood quality in Populus hybrids. *Can. Jour. Rec.* 20. Sect. C. 1.

40. Kribs, D. A. (1935). Salient lines of structural specialization in the wood rays of dicotyledons. *Bot. Gaz* 96, 3.

41. ———(1937). Salient lines of structural specialization in wood parenchyma of dicotyledons. *Bull. Torr. Bot. Club.* 64.

42. Paul, B. H. (1930). The application of silviculture in controlling the specific gravity of wood. *U.S.D.A. Tech. Bull.* 168.

43. Pearson, R. S. and Brown, H. P. (1932). The commercial timbers of India.

44. Pillow, M. Y and Luxford, R. F. (1937). Structure, Occurrence, and Prop. of compression wood. *U.S.D.A. Tech. Bull.* 546.

45. Priestley, J. H. (1932). The growing tree. *Forestry.* 6, 2.

46. ———(1935). Radial growth and Extension growth in the tree. *Forestry* 9, 2.

47. ———and Scott, L. I. and Malins, M. E. (1933). A new method of studying cambial activity. *Proc. Leeds. Phil. Soc.* 2, 8.

48. Rendle, B. J and Clarke, S. H. (1934). The Problem of variation in the structure of wood. *Trop. Wood.* 38, 6.

49. ———(1934). The Diagnostic value of measurements in wood anatomy. *Trop. Wood.* 40, 12.

50. Salisbury, E. J. and Jane, F. W. (1940). Charcoals from Maiden Castle and their significance in relation to the vegetation and climatic conditions in prehistoric times. *J. Ecol.* 28.

51. Solereder, H. (1908). Systematic anatomy of dicotyledons. English translation by L. A. Boodle and F. E. Fritsch.

52. Tippo, O. (1938). Comparative anatomy of the Moraceae and their presumed allies. *Bot. Gaz.* 100, 1.

53. Turrill, W. B. (1942). Taxonomy and phylogeny. *Bot. Rev.* 8.

EXPLANATION OF PLATES

Plate I.

Spruce, *Picea morinda* Link.

(X 20)

A. Fast grown B Medium grown C Slow grown.

Plate II.

Teak, *Tectona grandis Linn. f.*

(X 20)

A. Fast grown B. Medium grown C. Slow grown.

Teak, *Tectona grandis* Linn. f.

A. Fast grown (X 5) B. Slow grown (X 5).
C. Fast grown (X 200) D. Slow grown (X 200).

SECTION OF ZOOLOGY AND ENTOMOLOGY

PRESIDENT : PROF. A. B. MISRA, D.SC. (Lucknow), D. Phil. (Oxon.), F.Z.S., F.R.E.S.

SEXUAL PERIODICITY IN BIRDS WITH SPECIAL REFERENCE TO INDIA.

(*Delivered on January 7, 1948*)

Birds have been the object of considerable attention at the hands of the ornithologists in India. The first work of importance was published in 1862. This was followed by other studies by Hume, Blandford, Oates, Ward, Donald, Osmaston, Magrath, Jones, Whistler, Kinnery, D'Abreau, Stuart-Baker, Stevans, Law and Salim Ali. Most of these studies were of a taxanomic character, or of the nature of field notes on bird life. It must, however, be acknowledged that these works laid the foundation of ornithological studies in India.

An idea of the wealth of the Indian avifauna may be formed from the fact that Indo-burmese species and sub-species number 2,346 in contrast to the 3,198 species and sub-species that have been reported from the Palaearctic region or the 4,561 species and sub-species from the Ethiopian region.

It is well known that animals generally have, a more or less, definite breeding season (or seasons) in the year. The factors which regulate this annual recurrence vary from group to group, and, not unoften, from species to species. The more intimately we know a particular group of animals, the more easily do we discover that imperceptible differences exist among them. The reproductive cycle in animals is induced and regulated by several factors and conditions of life, besides an inherent reproductive rhythm the exact nature of which is hard to define.

A great deal of attention has been paid to this problem in recent years, and it has been attacked in different ways by different investigators. Even a cursory review of the recent literature shows that during the last 25 years a great deal of knowledge has accumulated on this subject which may profitably be summarized here.

During the past twelve years or more, some attention has been paid to this complex problem by me and my pupils in the Zoological Laboratory of the Benares Hindu University and we have investigated nearly twelve species of Indian birds in an effort to understand this problem.

THE REPRODUCTIVE CYCLE OF INDIAN BIRDS

The reproductive cycles of birds have been studied by a number of investigators in Europe and America, and the cyclical changes occurring in the testes of birds have been studied by them. An attempt has also been made by them to determine experimentally the factors governing the annual

recurrence of the changes in the avain gonad and in the secondary sexual characters . In India, however, this subject did not receive any attention worth mentioning till 1934.

An excellent historical resume of the subject is given by Bissonnette, Rowan, Marshall and Moore, and, therefore, no attempt will be made by me here to recapitulate well-known facts. Suffice it to say that the work done in recent years has brought about a complete change in our outlook on this subject. From the accumulated data we know that cyclical changes occur in the volume of the testes every year, which are accompanied by marked histological changes, that light plays an important part as an activator of these changes, that more than light qua light, muscular exercise and wakefulness are additional factors which play a part in the recurrence of the sexual cycle , that external factors like temperature, food, rain, etc. also matter in the process and that some of the secondary sex characters (the plumage and the beak colour) and behaviour are controlled by hormones released from the gonad or the hypophysis, or both.

Most of the work on this subject has been done in England, America and Canada, that is, in temperate countries which are situated geographically very differently from India. The studies which have been in progress in the Zoological Laboratory of the Benares Hindu University since 1934 have yielded results which challenge the validity of some of the accepted views and caution us about their general applicability to all species of birds living in different climes.

Gross Changes in the testis and the ovary of Indian Birds

The testis is bounded externally by the tunica albuginea within which are contained the seminiferous tubules, each separated from the other by the tunica propria, interstitial cells, blood cells and pigment. The tunica albuginea varies in the degree of its thickness at different times of the year. Ordinarily it is made up of connective tissue with the nuclei scattered here and there. The limiting walls of the connective tissue cells are too attenuated to be clearly discernible everywhere.

In January the testes of Mynah (*Acridotheris tristis*), for example, are considerably reduced in size. In February they begin to enlarge and continue to do so till June, when the testes are enlarged to the maximum extent. After June, the testes begin to dwindle in size and early in November the testes become reduced to a small size growing smaller still in December. In the female bird the ovary and the oviduct show signs of enlargement in the beginning of April and the surface of the ovary shows slight spherical prominences at this time. Towards the middle of May the oviduct begins to increase rapidly in length and by the end of this month its maximum size is attained. In June even eggs may be found in one or the other part of the oviduct. There is, therefore, a noticeable correspondence between the progressive and the regressive cycles of the gonads in the two sexes.

Microscopical changes in the Testis

Early in February the intertubular spaces begin to shrink and the tubules to enlarge in diameter. At this stage the spermatogenic cells of the tubules, still in the resting stages as shown by the condition of their nuclei, lie beneath the tunicae propria. In some of the tubules relatively bigger cells may sometimes be found in the centre of the tubules. A little of pigment may also occur in the inter-tubular spaces. The tunica albuginea is similar

to what it is in the month of January, but its inner portion, the tunica vasculosa, is more richly vascularized at this time of the year.

In the latter part of February, the tubules increase furthermore in diameter, the spermatogenic cells grow bigger in size but fill the tubules only incompletely, interstitial cells grow bigger in size and eventually some of them become glandular in function. The tunica propria becomes well defined and distinctly nucleated. The tunica albuginea tends to thin out as a result of the distention caused by the enlargement of the tubules and shows fewer nulcei in it. Blood corpuscles occur in the intertubular spaces. At this time the interstitial cells surround the seminiferous tubules in large numbers and not a few of them gain entry within the tubules through the breaches in the covering membrane the tunica propria. In this way, the cellular content of the tubules are replenished, the diameter of the tubules enlarges and, in due course of time, these new entrants become spermatogenic cells. A number of effete cells are discarded by the seminiferous tubules as evinced by their necrotic nuclei, which collect in the medullary portion of the tubules. These changes generally occur within the tubules in the month of March, but may sometimes be carried over even in April.

In April the tubules grow bigger still and contain primary and secondary spermatocytes and spermatids in different stages of development. The interstitial cells occur mainly in the triangular spaces enclosed between contiguous tubules, but may be found in all the inter-tubular spaces.

In May the process of spermateleosis is in full swing and a large number of spermatozoa are produced in the tubules and both tunica albuginea and tunica propria are stretched to the fullest extent by the distended tubules. In June the seminiferous tubules attain their maximum size and are full of sperms. The tunica albuginea and tunica propria are both extremely thin at this time of the year , so much so that, at certain places, the latter exists only in the form of a thin membrane or only incompletely covers the tubules. This is undoubtedly due to the increase in diameter of the tubules which means strain on the external coverings of the tubules and of the testis.

All the tubules of the testis are not in the same condition, and, even within the same tubule, different cells are in different stages of spermatogenesis. In July the condition of the tubules is, more or less, the same as before, blood corpuscles occurring in the intertubular spaces but interstitial cells being rather uncommon in them. The tubules are no longer compactly filled with spermatogenic cells and cellular debris and sperms abound in the lumen. Sperms are bundled together into clumps and lie with their tails turned towards the lumen of the tubule, whilst their heads face towards the cortex. In the lumen a certain amount of debris derived from the desquamation of the cells lies. A tendency on the part of the spermatogenic cells to recede to the periphery is noticeable at this stage leaving a wide lumen in the centre of the tubules.

In August the tide of sexual activity is passed and the seminiferous tubules shorten in diameter and contain fewer cells in them than in the preceding months. The lumen is occupied by granular protoplasm and the germinal cells lie in two or three layers close to the tunica propria. The nucleus of these cells is well defined and spherical, and a prominent nucleolus is also discernable. The general picture of the tubules is indicative of the cessation of activity.

Once again the intertubular spaces widen out and interstitial cells which were abundant in the triangular areas lie scattered about unrestrictedly.

In September the interstitial cells become more numerous and occur in the intertubular spaces. Sperms are absent from the tubules and germinal cells pass into dormancy. Pigment is absent. In October the tunica albuginea shows slight increase in thickness and nuclei become discernible in it. The seminiferous tubules are zigzag in outline perhaps on accout of the dimunition of their contents and of the pressure of the surrounding interstitial cells. The tunica propria is indistinct and spermatogenic cells are irregularly arranged inside the tubules and appear to be in a quiescent condition. Pigment is still absent.

In November the testis undergoes further regression and its histological condition is nearly the same as that in October.

In December the tubules shrink furthermore in size, the condition of the tunica albuginea is similar to that in the preceding month. Tunica propria is also indistinct and the interstitial cells are found in large numbers.

The important results obtained by us from the study of the cyclical changes in the gonads of nearly twelve species of Indian birds may be summarized as follow :—

1. The reproductive cycle of the male bird consists of two phases one of which is progressive and the other regressive. Roughly speaking the progressive phase begins in January and extends up to June /July ; the regressive phase commences from this time onwards and ends in December. Slight variation of two, three or four weeks' time occurs in some cases which one will do well to remember.

2. Almost identical changes occur in the testes of different species of Indian birds during the progressive and the regressive cycles. The sudden appearance of a large number of cells in the tunica vasculosa which make their way into the intertubular spaces, and, subsequently, play the role of interstitial cells is a noteworthy feature. The entry of some of these cells into the seminiferous tubules to replenish them, the transformation of some of these cells into the spermatogenic cells and the onset of spermatogenesis leading to the production of spermatozoa are some of the principal events that take place within the testes from January/February to July/August. During the regressive phase the seminiferous tubules shrink in size, the lumen practically disappears, the interstitial cells increase in number in the intertubular spaces, the tunica albuginea becomes thick and fibrous and the spermatogenic cells become dormant, and, lastly, a kind of intra-tubular selective elimination of weak and effete cells occurs within the tubules before the onset of the next progressive phase.

3. When the testes are enlarged to the maximum extent, the tunica albuginea becomes stretched to the utmost limit and is little more than a thin fibrous covering. The inconspicuousness of the nuclei may be due to the excessive attenuation of the connective tissue cells as the result of the pressure exerted upon this covering by the seminiferous tubules from within.

4. A large number of nuclei become discernable in the area vasculosa although the bounding cell walls are not distinctly visible.

5. These cells make their way in large numbers into the intertubular spaces and become mixed up with the so called interstitial cells.

6. The extent to which the interstitial cells wax and wane in relative number in the intertubular spaces during the progressive and the regressive cycles is really remarkable.

7. The seminiferous tubules are surrounded by innumerable interstitial and other cells and are besieged by them.

8. The tunica propria covering the seminiferous tubules is thin and becomes breached at certain points on its wall. The interstitial and other cells, lying in the intertubular spaces and at the ramparts of the tubules, enter inside them through these breaches in the tunica propria, and, eventually, become converted into spermatognic cells.

9. It is a remarkable fact, but nevertheless true, that somatic cells or cells of extraneous origin enter the seminiferous tubules every year in these birds and become part and parcel of them. It is, therefore, obvious that the germ cells in the seminiferous tubules of the Indian birds, at least in the species investigated by us, are replenished every year with fresh reinforcements of somatic cells (interstitial and other cells).

10. The tunica propia is not properly defined at all times of the year, nor is it equally well differentiated in all species of Indian birds. The general rule seems to be that it assumes prominence in the latter half of the regressive phase when the tubules are in a dormant phase. Breaches occur in it during the time of the enlargement of the testis through which the interstitial and other cells gain admission into the interior of the seminiferous tubules.

11. After the replenishment of the seminiferous tubules by these cells, a kind of intra-tubular selective elimination of cells takes place within them, resulting in the casting off of a number of worn out and effete cells into the medulla of the tubules.

12. Active spermatogenesis within the tubules leads to the production of spermatozoa, and, finally, to the depletion of the cellular contents of the seminiferous tubules.

13. When the wave of spermatogenesis is passed, the climax of the reproductive activity is over, the tubules shrink in size, the inter-tubular spaces widen out relatively and the interstitial cells become abundant again.

Name of the bird investigated.	Time of the progressive cycle.	Time of the climax of the reproductive phase.	Time of regression.
Milvus migrans	Middle of December to January.	February.	March to November.
Upupa epops	June	February to March	March to June
Ploceus phillippinus	January.	August/September.	October to December.
Bubulcus ibis.	January	July/August.	September to December.
Turdoides terricolor	January.	June/July.	August to December.
Dicrurus macrocercus.	February	July/August.	September to January.
Acridotheris tristis.	January	June/July	August to December.

Glands of Internal Secretion

A brief review of the nature and function of the glands of internal secretion, the effects that the secretions have on the metabolism of the body and the part they play in determining the personality (physical and psychic) of the animals may not be out of place here because, as we will see a little later, *they also exert a subtle influence upon sexual periodicity, secondary sexual organs and characters, postural lures, nidification,* etc.

The glands of internal secretion discharge their products into the blood stream and the lymph through which they are distributed to all parts of the body. The active chemical principles elaborated by these glands have a demonstrable effect upon the bodily form, emotions and behaviour of animals and have been collectively called "hormones."

The glands of internal secretion are the thyroid (including the parathyroid), pituitary, pineal, thymus, adrenal and the gonads. The thyroid gland, which lies in the neck region of the land vertebrates, was, according to Gaskell, a sex gland. From Petromyzon onwards this relationship, however, was lost, the thyroid having migrated more and more in the cephalad direction.

A relatively high precentage of Iodine is the unique feature of its chemistry. There are other internal secretions of the thyroid which lack iodine and have a function of their own, but they play a secondary role and their function is obscure. The rate at which the bodily processes go on seems to depend upon the amount of *thyroxin* present in the system. There is for every individual a constant metabolic rate which is increased or decreased by the output of thyroxin from the thyroid.

Whenever there is a deficiency of thyroid secretion, cretinism and myxedema result, and, apart from the physical and mental idiocy, *the sex organs also atrophy.* Similarly, an excess of it shakes up the nervous equilibrium voilently producing *sexual excitement* and highly pitched emotionalism.

The Pituitary

The pituitary is a small mass of tissue lying at the base of the brain. It really consists of two parts, known as the anterior and the posterior gland. Three kinds of cells occur in it. From each portion of the gland an active substance has been isolated. Evans obtained two chemicals from the anterior pituitary *which influence the sex organs and sexual activity.* The first extract from the anterior pituitary controls growth, particularly of the body parts and normal functioning of the thyroid and the adrenal galnds. Its hyperactivity gives rise to acromegely, which means enlargement of the extermities ; from the posterior lobe, another internal secretion commonly known as the *Pituitarin* has been secured. It raises the blood pressure, increases flow of urine from the kidneys and of milk from the breasts, contracts the bladder and the uterus, and controls the salt contents of the blood upon which its electrical conductivity and other properties depend. Hypopituitarism hinders and slows down growth producing dwarfs instead of normal individuals. An abnormal functioning of the anterior gland interferes with the proper functioning of the posterior gland the secretion of which acts like a tonic to the brain cells and also to the sex cells.

The glands of internal secretion of hibernating species of animals shows changes even in the cells of the pituitary which look shrunken in size as if they were also in a resting phase. A sort of cycle of periodic activity and inactivity seems to supervene in these glands also.

THE ADRENAL GLAND

Like the pituitary, the adrenal also consists of two distinct portions united together. In fishes, they arise separately and are independant. Each gland consists of a cortical and a medullary portion which are not sharply defined as portions of the tissue of one peneterate into the other.

In the Petromyzon the two parts are distinctly separate. The cells of the cortex are situated in the walls of the blood vessels of the kidney, whilst the medullary cells accompany the sympathetic nervous system. In Reptiles the two come together for the first time and in birds they become intermingled. The cortex produces an internal secretion which produces *both bodily and sexual maturity.* The acid produced in the blood and in the somatic cells is neutralized by the *cortin* produced by the adrenal cortex. In a way, therefore, the secretion of the adrenal cortex acts antagonistically to that produced by the thyroid. The medulla of the adrenal produces an internal secretion called *adrenaline*, which raises the blood pressure and excites the nervous system.

THE THYMUS

The thymus lies behind the breast bone and generally covers the great vessels arising from the heart. It is a conglomeration of the white cells of the blood known as lymphocytes between which occur groups of peculiarly staining Hassall's corpuscles. These are believed to be the seats of production of the specific hormone of the thymus.

Hens deprived of thymus lay *eggs without shells because of the disturbance of calcium metabolism* in them. More recently, these results have been confirmed by Riddle in the case of doves and he has suggested the name *thymovidin* for the internal secretion of this gland.

THE PINEAL

The pineal gland lies at the base of the brain behind and above the pituitary. It is made up of nerve cells containing a pigment. It possibly acts as a brake upon the adrenal cortex. It is commonly held that secretion of the pineal *inhibits sexual precocity* and *promotes pre-puberbal growth.*

THE PARATHYROID

Sometimes the parathyroids lie embedded within the thyroid in the neck and sometimes they are placed directly behind it upon the trachea. Removal of the parathyroid produces excitability of the nerves to a marked degree. The animal becomes intolerant to light and is thrown into convulsions the moment a ray of light reaches it. *The parathyroid also controls the amount of lime held in the blood and cells.*

THE TESTIS

The primary function of the testes undoubtedly was and still is to produce germ cells. Later on, it supplemented this function by producing an internal secretion, which acting on the accessory reproductive structures such as the epididymis, ductus deferens, seminal vesicles, prostrate gland, penis and other structures, keep them in a fit condition for the onset of the reproductive season. How the new function was acquired by the gonad, it is difficult to say. Why the secretions of the thyroid, thymus, pituitary and the adrenal were not sufficient for all purposes is not at all clear to us, but

the fact remains that the testes have also become the seat of formation of *a special hormone.*

As early as 1869, attempts were made to obtain from the testes a substance that might restore masculinity. Successful lipoid extracts from the fresh testes of the bull enabled McGee in 1927 to make a beginning towards the separation of the active principles of the testes and from that time onward, the developments in this direction have been phenomenal.

An androgenic substance was separated from the human male urine in 1929 and crystallization of two active chemical stbstances (*androsterone* and *dehydro-androsterone*) from urine extracts was reported in 1931-32. Attempts were made to produce these substances synthetically in the laboratory in 1934 and preparation of pure chemical *testesterone,* different from *androsterone,* was accomplished in 1935 from the urine.

These chemical researches have proved the testis to be a gland of internal secretion,. It is now firmly established that both testis and ovary produce certain hormones into the body which give impetus to a number of accessory sexual structures and secondary characters to become functional in the breeding season.

THE OVARY

Three different hormones are produced by the ovary. These are known as *Folliculin* (*Oestrin*) from the follicular fluid, *Lutein* from the corpus luteum and the third substance from the interstitial cells to which no distinctive name has yet been given. Besides these, a secretion has also been isolated from the placenta in the case of the Placentalia.

The endrocrine function of the ovary is necessary for the development and maintenance of the accessory genital organs and the secondary sex characters in the female just as androgenic substances are necessary in the case of the male. In the nonpregnant mammalian female secretion of the primary ovarian hormone waxes and wanes at regular intervals, and if ovulation occurs it is supplemented by a distinct progestational hormone. These hormones have been isolated, crystallized and even synthesized chemically. With the onset of the pregnancy, a modified endocrine balance, supplemented by the internal secretion of the placenta, supervenes. At parturition, when the placenta is discarded, another major endocrine adjustment is necessitated in order to initiate and maintain lactation. It has been known for a long time that the removal of the ovary affects sexual function and causes atrophy of the accessory genital organs and secondary sexual characters including the mammary glands.

It is now possible to reproduce nearly all the sexual functions, except egg production, by injecting ovarian hormones into ovariectomized animals thus simulating the endocrine function of the ovaries.

Oestrogen is used as a collective term for all substances producing oestrous growth in vagina, uterus, mammary glands and the female secondary characters. Chemical substances like *estrone* from pregnancy urine, *estradcole* from the follicle of the ovary, *equiline* and *relaxine* and many other commercial preparations are now available in the market.

Primitively the gonads had a segmental arrangement and extend throughout the greater number of body segments and the primitive germinal cells were at first, similar to one another . But, in the course of evolutionary development, a differentiation took place resulting in the formation of the

male or the female gonad. The primitive vertebrate female had several pairs of segmentally arranged ovaries which produced a large number of eggs. These, later on in the course of evolution, became contracted in length and the number of eggs produced by them also decreased considerably. The eggs, instead of being expelled to the exterior through a genital pore or through a simple duct to be fertilized externally, tended to be retained inside the body and the mechanism of internal fertilization and of intra-uterine care of a few eggs to a late stage of development was evolved.

It is difficult to say just at what time or stage the ovaries acquired endocrine function, but it is known that the oviduct in birds involutes to a mere thread-like structure during the non-breeding season. With the approach of the breeding season and the growth of eggs in the ovary, this organ hypertrophies in preparation for its period of function. The epithelium lining the tube shows much activity and division of cells, and secretion of the albumen and of the shell takes place. The latter function is probably under the control of the ovaries for *estrogen* has been extracted from the ovaries of birds and the oviduct of fowl has been found to react to injected estrogen. Since the follicular epithelium is very thin in birds, there is no structure in the ovary of birds which can be homologus to the corpus luteum of mammals. Consequently post-ovulatory phases of hormonal control of the activities of the oviduct probably depend upon the production of successive generations of eggs, or it may be that the pituitary of birds contains both follicle stimulating and luteinizing factors.

These glands of internal secretion act independently and also conjointly for maintaining the characteristic metabolism of the animal. Separately they produce specific effects upon special parts of the body as already indicated, but they also constitute a kind of inter-locking directorate with many a 'Stop and Go' controls.

Factors Controlling Reproductive Activity

Generally speaking there is an alternation of periods of rest and of activity in animal reproduction. In correlation with this, *hormones* are periodically elaborated by the glands of internal secretion and by the gonads which, acting on the body of the animal, incite the various acts of reproduction and set the whole machinery of reproduction into motion.

Critical Examination of the Factors Involved in Sexual Periodicity in Birds

To cut a long story short, it may be said that the hours of sunlight, muscular excercise, wakefulness, ultraviolet radiation, and to a lesser extent temperature, food, rainfall and humidity are said to be the external factors concerned in regulating sexual periodicity in birds. In recent years, the endocrine function of the anterior lobe of the pituitary has been emphasized in this connection, and a large volume of impressive results have been obtained to establish the importance of its role.

Marshall in his Croonian Lecture before the Royal Society of London in 1936 attached much importance to the "exteroceptive" (external) factors. Above all these, it has been found necessary to invoke the aid of an inherent *reproductive rhythm* because the external factors, even when all is said and done, seem inadequate to explain fully the annual recurrence of the reproductive cycle and of other secondary sexual changes in birds,

As a result of the work done by us on nearly twelve species of birds in the Zoological Laboratory of the Benares Hindu University it has been found that, taking as a whole, the birds, from this point of view, fall into certain well-defined categories, because all of them do not seem to be governed by the same laws. For instance, the peak of reproductive activity of *Milvus migrans* lies between the middle of February and March, that of *Acrido-theris tristris* and *Turdoides terricolor* between the milddle of June and July, and in the case of *Dicrurus macrocercus* it lies between July and August. The same in the case of *Bubulcus ibis* lies in August, and, lastly, the peak in *Ploceous phillipinus* is reached in September. Strikingly enough, *Tyto alba* is at the zenith of its reprocuctive activity in October and *Bubo bubo* in December. It will, therefore, be seen that all species of birds do not breed at the same time inthe year, and can, from this point of view, be grouped into separate categories. The question natually arises, Why do some species breed at one time of the year and others at another ? What are the factors determining the appropriateness of a particular time of the year for the breeding of a particular species ?

A number of environmental factors are said to have a bearing upon the phenomenon of sexual periodicity in birds, and we may critically examine the evidence at our disposal in order to test the validity of them.

Light—Rowan showed for the first time that light was a factor provoking reproductive activity in birds. Bissonnette showed that intensity and wave-length as well as the daily ration of light were factors concerned in promoting sexual activity. This idea was confirmed by Baker and Ransom from their work on *Microtus* and also by Hill and Parkes in the case of ferrets.

Later it was suggested that it was not light qua light that mattered so much as hours of sunlight or the daily ration of sunlight which was available to the animal. In temperate countries we have extremes of temperature, and fickle hours of sunshine. It, therefore, occurred to me that in India where sunlight is generally so abundant all the year round, light may not be such a potent factor as in the temperate countries.

On an average we have at least ten hours of sunlight throughout the year in Benares where most of our investigations have been made. From the beginning of April to the beginning of September there are at least 12 hours of sunshine ; the maximum of 13 hours being available in July.

In *Tyto alba* and *Bubo bubo* the enlargement of the testes begins in September and in November respectively, when the hours of sunshine are on the decline.

Name of the bird.	Climax of testis enlargement	Hours of sunshine.
Milvus migrans	Middle of February & March	11 ·25 hours.
Acridotheris tristris	Middle of June and July	13 ·75 hours.
Turdoides terricolor	Middle of June and July	13 ·75 hours.
Dicrurus macrocercus	July and August	13 ·50 hours.
Bubulcus ibis	August	13 ·25 hours.
Ploceus p illipinus	September	12 ·50 hours.
Tyto alba	October	11 ·75 hours.
Bubo bubo	December	10 ·75 hours.

All the birds examined by us are *non-migrants* and were secured from their native haunts in this locality so that they receive the same quantum of light. Light qua light can be an important factor only in countries where there is considerable difference between the hours of sunshine during the different seasons of the year (winter, spring, summer and autumn), but in a place like Benares the contrast between the seasons is not so sharp as in Canada, U.S.A., England or in Central Europe. Therefore, it seems logical to argue that light qua light does not play a very important part in inducing sexual activity in Indian birds.

Ultra-violet radiation—It is held by Marshall, Marshall and Bowden and Baker that ultra-violet radiation also induces periodic sexual activity in birds and mammals, and that increased artificial dosage may even bring about precocious and untimely maturity in them. Whilst the general effect of ultraviolet radiation on animal life is universally recognized, yet the part played by radiation in provoking seasonal activity in birds was not brought into sufficient prominence until Bissonnette determined the effect of different portions of the spectrum of light upon the testes of birds. The work of Bissonnette, Benoit, Scott and Payne, and Marshall and Bowden has shown that, even among birds, all wave lenghts of light are not equally effective, and that the most effective one *probably* varies with different species of birds.

Against this view, we have to reckon the findings of Rowan and Riddle who found that the reaction of testes to light containing ultraviolet does not differ in any essential respect from that induced by light of similar intensity, lacking the ultraviolet component. Marshall and Bowden, however, found ultraviolet rays effective stimulants in the case of ferrets. It, therefore, seems to me that birds and mammals react differently to the ultraviolet radiation. The former responding in a lesser measure than the latter, or not at all.

Ghosh's work on the distribution of ultraviolet intensity in the sun light in Calcutta during the year 1931-32 shows that the maximum amount of it is available in June and the minimum of it in December.

A higher quantum of ultraviolet light nearly 1/5 of that in June is available in March also. If the graph of the annual distribution of the ultraviolet light in India (Calcutta) were to be superimposed upon the graphs of the reproductive cycles of the Indian birds then some sort of a coincidence is observed, but the cases of *Tyto alba* and *Bubo bubo* stand out as remarkable exceptions, proving thereby that *at least* these birds do not require the quantum of ultraviolet light that is required by other species of birds. The other thing that strikes me is that, if increased ultraviolet radiation is a provocative agent stimulating the gonads into functional enlargement and activity, the incidence of greater amount of ultraviolet radiation in the sunlight ought to precede the period of enlargement in volume of the testis by a month or fifteen days. May it, therefore, not be that this coincidence is merely accidental ?

Temperature—A study of the relevant literature shows that widely divergent views are held in regard to temperature as being an important factor concerned in the phenomenon of sexual periodicity. Rowan mentions that "low temperature undoubtedly inhibits breeding even in wild birds and later nesting seasons are a common accompaniment of an inclement spring". Baker has also reported that the black bird, *Turdus merula*, commences to breed earlier in the south of England than in the Scottish counties north of 56° of Latitude. Baker further writes that a general view of breeding seasons

of birds throughout the world suggests that "temperature and length of the day may be the proximate causes in boreal and temperate zones, and rain and intensity of illumination within the tropics".

Against this we have the opinion of Bissonnette and Chapnick who maintain that "there appears to be no parallelism between the temperature fluctuation and testis size." Rowan writes that, "it should be borne in mind that Millards winter in Alaska, Iceland and even in Greenland and *their gonads are already increasing at a time when those of most birds are still decreasing or are at their winter minimum*".

The mean temperature begins to rise in Benares steadily from February onward, and continues to do so till the middle of May. Thereafter, the mean temperature decreases till it is appreciably reduced in August. There is a slight rise in temperature in the first fortnight of September after which it falls in October, November and December. As mentioned before, the crests of the reproductive waves of several birds studied by us in Benares lie between April and September; but the case of *Milvus migrans, Tyto alba*, and *Bubo bubo* present difficulties and cannot be reconciled on this ground. Therefore it seems to me that temperature is not one of the main factors concerned in inducing sexual preiodicity, but that it plays only an auxilliary part in it.

Rain——Baker has collected sufficient data to show that rain is a factor concerned in controlling the breeding seasons of birds, but he is not very sure whether the stimulant is the rain itself "or the small saturation deficit of the atmosphere or the existence of the ponds and pools or else the green vegetation resulting from it".

The record of fortnightly rainfall at Benares, according to the data supplied to us by the Indian Metereological Department, shows that the the wettest months of the year are July, August and September. If rainfall induces changes in the size of the gonad preparatory to reproduction, then the progressive changes in the size and the histology of the testes of *Bubulcus ibis, Dicrurus microcercus, Turdoides terricolor, Acridotheris tristris and Ploceus phillipinus* should commence in July and not in January/February. Moreover, birds like *Milvus migrans, Athene brama* and *Bubo bubo* show the greatest enlargement of their testes in the months of February/March and December. The facts in our possession do not enable us to share the views of Baker. It seems to me that it is not possible to generalize or to be dogmatic in this repect. In the case of those birds in which rainfall seems to provoke reproductive activity, it may be acting as an external factor through the eyes or through special sense organs distributed over certain other parts of the body which are as yet unknown to us.

Food—Baker writes that starlings do not respond to light if kept on a poor diet. Marshall also recognizes food as an important factor, because he says that sexual periodicity is conditioned by the general environment just as all vital processes are so conditioned and that food supply is of prime importance. The case of marmorets at the Lister Institute as reported by Marshall proves that generative functions may be inhibited by faulty nutrition. Rowan, however, regards food as an insignificant factor. Bissonnette considers that deficient food may act as a limiting factor even counteracting the stimulative effect of light on sexual activity. The food of two species of Indian birds was studied by us in detail in the Zoological Laboratory of the Benares Hindu University and checked with data obtained from Mason's Memoir of the Imperial Department of Agriculture in India,

Volume III, 1912, on the subject. When the results were tabulated and analysed it was found that food cannot be regarded as a provoking factor, but its general effect on the health of birds cannot, of course, be questioned.

The effects of inadequate diet, which often results in general undernourishment , have been studied by several workers on mammals, but no work has been done on birds. We can, therefore, speak only from analogy in the absence of direct evidence. In the case of rats it has been reported that when the body weight decreases by 25 to, 30 per cent of the original weight, then pycnosis and necrobiotic changes occur in the spermatids and spermatocytes. Spermatocytes lose their ability to undergo spermatogenesis. Return to normal diet results in complete repair of testis injury in one to three months, depending upon the extent to which damage is done to the gonads in the inanition stage.

The case is, however, different in the case of Amphibia where we find that the testis and the ovary are already much grown when the frogs or the toads wake up after their winter or summer sleep. Therefore, it looks that in different groups of animals growth in volume of the testes and their functional activity is differently affected by inanition. The preponderence of evidence indicates that the testes of birds are very sensitive to general inanition, and that they are particularly susceptible to vitamin B deficiency.

Suppression of spermatogenesis, reduction in size of the seminiferous tubules, sloughing off of spermatids, reduction in the diameter of the tubules, and abundant pycnosis occur whenever there is a deficiency of vitamin B. Interstitial cells show hypertrophy and hyperplasia as a result of B deficiency. Our knowledge of this subject, however, is so limited that it is not possible to express any opinion at this stage on the role of B2 deficiency. The ovaries of polyneurotic birds undergo less marked atrophy than do the testes,although it has been mentioned by some workers that the resulting follicles are minute in size and that degenerative changes take place in the ova and in the nuclei of the interstitial cells.

Vitamin C occurs in the anterior pituitary and the interstitial cells of the sex glands. As far as we know, at the present time, vitamin D has no specific relationship either with reproductive function or with sex-hormone production. There is some evidence to show that vitamin E, whose absence has been shown to play an important part in the differentiation of testes in rats, may be produced in the interstitial tissue cells. The testis of the chick has been reported to be resistant to deficiency of vitamin E or else it may be that the diet employed in the experiments was only partly depleted of this vitamin.

Some speculation has been rife about the role of vitamin E in hormonal function of the sex gland and its relation with the anterior hypophysis. A similarity between the effect of hypophyseal disturbance and of vitamin E deficiency upon the feathers of i en suggests that a link exists between them.

The Unseasonal Climate of Espiritu Santo in New Hebrides and the Reproductive Activity of *Pachycephla*.

The island of Espiritu Santo, New Hebrides (Pacific), lies 15° South of Equator, and has "a remarkably unvarying climate." On account of its proximity to the equator it has little seasonal change in temperature.

Pachycephala pectoralis is a non-migratory species of Passerine birds which lives in the natural rain-forests below the leaf canopy and nests at

accessible heights. The male bird is brilliantly coloured which is in sharp contrast to his mate. This species is insectivorous.

A study of the growth in weight of the testis and the abundance of sperms in it showed that the testis weighs four times as much in June/July as in December. That such an exceptional increase in weight of the testis should take place in the unvarying climate of Espiritu Santo is very significant. It will be noticed that the reproductive season is as restricted as in birds inhabiting the northern parts of Europe, where seasonal changes in climate are very marked.

Another striking point is that this bird moults like birds of the temperate regions when it has finished breeding..

A study of the metereological data of the Espiritu Santo does not provide any obvious clue to the proximate cause of the breeding season. The breeding season of this bird extends from May to July, and the length of the day at this time of the year is 11.15 hours only, which is practically the lowest for the whole year. Therefore, it cannot be said, at least in this case, that increase in length of day is the cause of breeding, because the birds breed at a time when there is less sunshine.

Some very intersting results have been obtained by Baker from the study of the breeding seasons of the *Pachycephala* sps. in different parts of the South Pacific Ocean. He collected data of the egg seasons in Nothern New Hebrides and similar latitudes in Tasmania, non-tropical Australia, tropical Australia and the season was found to extend from September to November. Further south in Tasmania, the season does not start before September. In tropical Australia the season is definitely later than in the non-tropical parts because it extends from September to March. At this time the sun is approximately overhead at mid-day. In New Herbrides the egg season occurs when the sun is lowest in the sky (that over the Tropic of Cancer). In tropical Australia it is coincident with the overhead sun. Baker concludes that "whatever may control the egg season in the bird without the tropics, it is not length of the day nor the position of the sun. Rain fall is not an explanation for the height of the egg season is reached in the wet season in tropical Australia and in the rainless season in the New Hebrides".

The Internal Rhythm

During the course of this discussion, the part played by the external environment, hormones and the internal rhythm has been emphasized. In a general way it may be said that the hormones and the environment control the seasonal changes in some cases, whilst hormones and the internal rhythm predominate in others, it being understood that the organism can never be regarded as completely freed of the environmental control. Baker and Ranson attacked the problem by collecting information on the breeding seasons of Southern Hemisphere birds in the Northern Hemisphere. They found that most of the birds of the Southern Hemisphere when imported to the Northern Hemisphere changed their rhythm so as to breed in the corresponding season of the Northern Hemisphere. Some birds of the Southern Hemisphere, having a limited breeding season in their homeland, bred all the year round when imported into the Northern Hemisphere. Some birds of the Southern Hemisphere, when imported into the Northern Hemisphere bred in the same calender months. Imported specimens exhibited an internal rhythm, breeding season not being easily influenced by the environment. It will, therefore, be seen that all birds do not behave in the same way, but some birds do exhibit the influence of internal rhythm.

The internal rhythm might have been induced in the birds genetically or by periodicity in the environment. Baker says : "We can imagine a bird endowed with the innate quality of tending to become ready to breed at the age of one or two or three years and at approximately annual periods thereafter. One can also imagine a bird with no innate rhythm of reproduction but only with an innate tendency to breed under certain environmental conditions ; such a bird can be imagined to have an internal rhythm impressed upon it by the environment. But it is unthinkable that genetically induced internal rhythm could alone be responsible for annual periodicity in any species of animal or plant to the exclusion of environmental influences, for reproduction will gradually get out of step with time like a clock however well made which is never put right. Nevertheless , internal thythm may be a constituent part of the cause of breeding seasons in many species which are mostly controlled by the environment". The work of Marshall on South Down Sheep, Red-deer and other mammals has yielded results which are opposite to that found by Baker in the case of birds. It may be that the nature of the sexual rhythm and its relationship with the environment is different in birds and mammals.

The Role of the Central and Sympathetic Nervous Systems in Reproduction

Experiments have been made on partially or totally decerebrated young and adult male rabbits, rats and cats. Golts, Sherrington and Cannon have also studied the effects of transection of the cord in the cervical and and lumbar regions, and of the effect of sympathectomy. It was found that transection and sympathectomy do not produce any pronounced deleterious effect upon reproduction.

It will, therefore, be seen that the exact role of the central and sympathetic nervous systems in the execution of sexual acts is not fully understood by us. We lack conclusive evidence as to what specific parts of the nervous system become eroticised by internal secretions. What part the special senses play in the excitation and consummation of the sexual acts in mediating the external stimuli is also not very clear to us.

Beak Colour as an Indicator of Sex-hormone

In many birds the colour of the bill changes during the breeding season. In the case of the African weaver finches, *Pyromelana sp.* and *Quelea sp.*, it was found by Witschi that the colour of the beak of the male is under the influence of the male hormone, while the plumage is under the influence of the pituitary. In the case of the female, the plumage is under the dual control of the pituitary and the ovarian hormones which neutralize each others effect. The oestrogenic hormone inhibits the deposition of colour on the beak.

In the English sparrow and some other finches both sexes have a horn-brown bill during the quiescent phase. During the reproductive phase, this changes in the males into a jet black. In the red-bill weaver, males and females have brilliantly coloured red bills during the inactive phase, which turns into yellow during the breeding season in the female only. In the Parokeets the sexes differ mainly in the waxy skin over the root of the bill. It is blue in the male, and brown in the female during the breeding season. Obviously, one of the alternate bill colours is neutral, not controlled by hormone and persists during the quiescent phase ; the other colour appears during the breeding season only. The bills of a number of species of Indian birds were studied by me in the Zoological Laboratory of the Benares Hindu University and an accurate record of the changes in colour was maintained

for four years. As a result of this study a number of points hitherto unnoticed by others have been recorded. The changes occurring in a few species attracted my attention particularly, and a mention of them is, therefore, being made here.

Observations made at Benares

In the case of water hen (*Amaurornis phoenicurus*) the beak, in both sexes, has a dash of crimson red at its base, which in the regressive phase of the reproductive cycle changes into metallic blue in both cases. But in *Ploceous phillipinus* the beak of the male is, at first, pinkish yellow which, at the climax of the reproductive cycle, acquires a metallic grey hue. The female of this species does not, however, acquire the metallic grey tint but the basic pink-yellow becomes intensified a little. In the case of the cattle egret (*Bubulcus ibis*) the beak of both the sexes is similarly coloured except for the fact that the crimson red colour on the beak is sharper in the male than in the case of the female, and the purple blue round the eyes is also a shade brighter in the male than in the case of the other sex.

It will be noticed from this that the bill of certain birds can also act as an indicator of the sex hormone but the intersting point that emerges out of these studies is that in some species the bill colour is controlled by the male sex hormone, and, in other cases, by the opposite hormone. A kind of genetical (or constitutional) physiology seems to influence the colour of the bills of birds up to a certain stage, after which a hormonal influence, acting on this foundational colour, seems to determine what colour the bill will assume during the breeding season.

Cytological findings having a Bearing on avain Reproduction

Allender mentioned that mitosis did not occur in the gonad of the English Sparrow during the day time. This was corroborated to be true by Loisel and Foley ,and Riley said that a lowering of the body temperature by about 5°F. takes place between 2 to 4 A. M.

Baldwin and Kendeigh have shown that the body tenperature of birds fluctuates during the day. They found that the temperature of the body of a bird is 3° higher during the day than when it is at rest. Wetmore determined body temperature of a large number of birds and found that the daily variation in temperature ranges from 0.7 to 3.0 degrees according to the species of the bird.

It may be assumed for general purposes that body temperature of the birds rises during the day when they are flying or otherwise active, and falls at night when they are at rest. Allender, therefore, argued that division stages take place in the testes at night while the birds are at rest and the temperature of the body is at its lowest.

During the course of our studies, when thousands of sections were examined by us, we were puzzled to find mitotic figures in the sections of the testes of Indian birds, which had been fixed for sectioning during the day time. It, therefore, seemed worthwhile to study this problem closely.

Results obtained at the Benares Hindu University

The testes of two species of birds, *Passer domesticus* and *Acridotheris tristis* were fixed at all hours of the day in appropriate fixatives, sectioned and studied from this point of view.

It was found that mitosis occurred in these two species of Indian birds at all hours of the day and the night. In this respect these Indian birds differ from the English sparrow.

Amitotic divisions of the nucleus were also found to occur in these two species of Indian birds. The cytologists of the old school looked upon amitosis as a symptom of approaching degeneration and death (vide Wilson p. 215), but it is now commonly agreed that this is far from being so. On the contrary, sufficient evidence has been adduced by Meves, Megregor, Child, Patterson, Hargitt and others (see Wilson p. 212-219) to show that both mitosis and amitosis occur in embroys and in adults of animals as the normal means of multiplying their nuclei and cells. The evidence at our disposal clearly indicates that the occurrence of amitosis by no means precludes the asumption of mitosis and is not to be regarded as a symptom of degeneration.

During the course of the routine examintion of hundreds of sections of the testes of pigeon, we came across abnormal sperms, reference to which has been made by Guyer and Smith. These authors were, however, unable to trace all the stages leading to the formation of abnormal spermatozoa. We noticed that , whilst normal spermatogenesis proceeds uninterrruptedly in some of the seminiferous tubules, abnormal stages occur in others, sometimes even inside the same tubules. Abnormality sets in mostly at the primary spermatocyte stages by reason of irregularity in the reduction division due to the incompatibility of the chromosomes. This results in the production of abnormal secondary spermatocytes, possesssing an abnormal garniture of chromosomes. Sometimes a primary spermatocyte transforms itself into the spermatid without undergoing the first and the second maturation division, and the same may happen to a secondary spermatocyte which may likewise avoid a second maturation division . These events result in the production of abnormal spermatozoa. Abnormal sperms of several kinds, viz. (1) giant sperms (2) double, triple, multi-headed sperms occur in the domestic pigeon.

Giant sperms result from the precocious primary or secondary spermatocyte or from a spermatid which has inherited more than its normal share of the chromosomes from the I-cyte or from the II-cyte on account of the irregular assortment of chromosomes. Giant sperms may also be produced by the fusion of two spermatids lying adjacently. Monstrosity in sperms has been shown to be due to the branching of the nuclei of abnormally behaving spermatids. Twin sperms have also been noticed and their origin is due to the daughter nuclei remaining together , resulting after the maturation division, due to the failure of the partitioning cell wall to form. Bifid sperms have been traced to originate from spermatids whose nuclei undergo partial bissection.

The irregular behaviour of the nucleus and the chromosomes seems to to be due to the incompatibility of the plasma of the different strains which is commingled in the hereditary make up of the pigeon. In other words , the abnormal spermatogenesis is due to certain intracellular factors of a genetical nature which affect the cellular physiology in such a way as to make normal spermatogenesis impossible.

SIDELIGHTS ON AVIAN REPRODUCTION

From our knowledge of the avian gynandromorphs and other sex intergrades we know that the balance of control may shift from one sex to the other resulting in the production of various degrees of sex intergrades,

A genetical explanation of the origin of the sex intergrade was given by Goldschmidst, and later on, by others ; but Witschi's experiments show that the differentiation of the normal sex takes place when the internal equilibrium within the developing embryo is properly adjusted. When the time factor, dosage and the potency vary, or act early or late, the direction of development may be switched from one sex to the other, resulting in the production of various grades of intersexuals. In the case of mammals, including man, the results of castration and enuchoidism have shown that even in the adult the characters and psychic qualities of the other sex may be produced when the controlling influence of the gonadal hormone decreases in quality or quantity . In adult birds small scale changes in restricted areas of the skin can be induced by means of grafts or hormonal treatment . Injections of thyroxin, theelin and other gonadal preparations have shown that different protions of the skin of birds have different potentials and the threshold of this potential can be crossed by means of suitably planned experiments. The results of these experiemts show that birds as well as other vertebrates are fundamentally ambisexual.

It is known that the plumage is developed differently in the two sexes. Often the male possesses plumage for the sake of effective adornment and the male birds develop colourful feathers and distinctive plumes in the breeding season every year. Sometimes there is scarcely any difference between the two sexes except in regard to the development of distinctive marks or colouration in limited areas of the body which disappears after the breeding season is over. As a result of the work of Danforth, Masui, Juhn, Gustavson and Lillie it has been found that there is a difference in the rate of growth of the feathers at the base and at the apex, and that even the barbs show a gradient in consequence of which the tips have a higher threshold of reaction than the more basal points. By taking these facts into consideration it is possible for us to create regional as well as individual gynandromorphic patterns by means of suitable injections.

Ovulation is an important event in the sexual cycle of a female bird. The ovulatory process is induced by the action of the gonadotropic hormone. In the case of birds, the follicle stimulating hormone-prolactin-is liberated by the hypophysis. Stieve found that unfavourable environmental conditions may inhibit maturation and ovulation, the secretion of the hypophysis notwithstanding.

The experimental work on mammals has shown that they do not come under one single rule. The mammals may be divided into two groups : (a) those in which P.U. causes growth of follicles and ovulation and (b) those in which it does not. The hypophysis of these two groups would be fundamentally different ; in one class (rat, cat, oppossum) the anterior pituitary supplies sufficient follicle stimulating hormone to cynergize with introduced luteinizing hormones to bring about follicular maturation and ovulation ; in the other group, this mechanism does not work.

The vertebrates can *probably* be divided, like the mammals, into two groups : (a) those that do and (b) those that do not require sex stimulation for ovulation and oviposition. Among birds the domestic hen has been bred for egg-laying and will certainly lay in complete isolation ; this is probably also true of other domestic and semi-domestic fowls. It is, therefore, to be inferred that the whole train of physiological and behavioral mechanism, which is necessary for reproduction, is set in motion by the company of the

male. The domestic birds, in which the male has been more or less dispensed with and in which the sexual stimulation is not necessary, may be regarded as having evolved some other kind of adjustment in the working of the glands of internal secretion so that sexual stimulation has become unnecessary in their case for breeding.

• Sexual periodicity, reproduction and behaviour are controlled by the endocrine glands and the gonads. The endocrinal glands are themselves subject to external influences acting through the sense organs and the nervous system.

The phylogeny of the hormones is one of the most perplexing problems in Biology still awaiting solution. In the absence of the appropriate stimulus the development and maturity of the cells and tissues of the organism do not occur. The hormones, which were first elaborated by certain cells to assist the metabolism of other cells, have now become so indispensable to them that they cannot function without them.

It, therefore, becomes necessary for us to view this problem of sexual reproduction and periodicity in elastic terms, for a rigidity in our attitude will let us understand only a part of the question and not the whole of it. Confining our attention to birds, for the moment, it has been found in the course of experimental work that not only do breeds of the common fowl differ in respect of reponsiveness to the same hormone, but even different regions of the same bird have their own individual thresholds of reaction. This means that each bird is a kind of "*functional mosaic*" which is differently patterned in different breeds of birds.

In the case of higher animals the internal rhythm is correlated with seasonal changes and other environmental factors which probably act through the nervous system upon the anterior pituitary and thus upon the testis or the ovary. Witschi has analysed the hormonal control obtaining in two species of African weaver-finches during the breeding season. In the case of the male of *Pyromelana sp.* the active hypophysis releases hormone which induces growth and maturation of the testis and the development of the nuptial plumage. This in its own turn releases androgenic hormone which stimulates the accessory sex organs and causes the deposit of black pigment in the bill. But in the case of the female of *Quelea sp.*, another species of African waever-finch, the pituitary hormone stimulates growth of the ovary leading to maturation and ovulation and the activated ovary releases oestrogenic hormone which stimulates the accessory sex organs but inhibits the deposit of pigment in the bill and off sets the action of the pituitary hormone on the plumage.

This work of Witschi is of first rate importance because it enables us to understand in a clear way the interlocking control of the glands of internal secretion which secures the well-ordered working of the whole machinery of avian reproduction. I have mentioned elsewhere that animals belonging to different classes and species seem to stand at different levels in the scale of evolution and have their own distinctive threshold of reaction although conforming to the general scheme of sexual reproduction and behaviour. Witschi's experiments on the weaver-finches show that even the two sexes of closely related genera or species of birds do not have a common foundational plan of sex physiology.

A well-knit complex of multiple physiological factors seems to govern the onset and stoppage of the reproductive processes and activities in birds. It would be wrong to assume that this or that factor is the sole determinant of the process.

The process of the activation of the pituitary, its effect upon the gonads and the accessory organs of reproduction, secondary sexual characters, courtship and display, nest-building ,and migration constitute a chain of events which are linked together by means of several factors whose isolated study enables us to see only a part of the process and not the whole of it.

In the present state of our knowledge ,it must be confessed that, whilst the broad outlines of the processes of reproduction and of the nature of the inciting factors are known to us, yet there are many limiting factors at work which are eluding our comprehension. It seems as if the genic control of the endocrine organs, the activation of the gonads, susceptibility of the soma to the endocrine influences, selective responsiveness of the organism to external environmental factors and the accumulated effect of the environment upon the organism, living through space and time, have resulted in the establishment of certain designs of physiological action and reaction which are not the same in all species of birds, although the foundational plan is the same, and which may slightly vary even in the two sexes of closely related species or genera of birds. Believe it or not, but the fact that emerges out of all these studies is that the whole of the soma of the bird is to be regarded as a museum of the trophies won and the losses sustained, both in times of war and peace, during the aeons of time through which the birds have lived and survived.

SECTION OF PHYSICS

PRESIDENT : DR. L. A. RAMDAS, M.B.E., M.A., Ph D., F.A.Sc., F.N.A.Sc., F.N.I.

THE PHYSICS OF THE BOTTOM LAYERS OF THE ATMOSPHERE

(Delivered on January 3, 1948)

INTRODUCTION

The Physics of the *Upper* Atmosphere has been dealt with more than once by previous presidents of this section. On this occasion I propose to make a brief and rapid survey of some of the problems concerning the *Bottom Layers of our Atmosphere* and the Soil Layers immediately in contact with them.

Considerations relating to the upper regions of the atmosphere will be brought in whenever these have a bearing on our main topic.

The subject has a special importance not merely for the meteorologist and the physicist. The biologist, the engineer, the medical man as well as the farmer, the geographer, the geologist, in fact the entire Plant and Animal Kingdom are *vitally concerned* with the air and soil layers in which they actually live.

The early meteorologist could only study the weather as far as it could be seen and understood from the surface of the earth ; but it soon became clear that the "Drama of Weather" is enacted in three dimensions and that for a full understanding of the various "acts" and "scenes" in this vast drama one must explore the whole atmosphere.

The "troposphere" or the lower portion of the atmosphere which is the seat of most of the major weather phenomena like the production of clouds and rain, storms and depressions, etc., may be treated as a vast thermodynamic "Heat Engine" with water vapour as the working substance. It must be emphasised, however, that equally fundamental processes are in operation in the atmosphere, both *below* and *above* the region of clouds.

One can go further and say without the least exaggeration that the whole atmosphere is a vast "International" open-air Laboratory in which practically every Department of Classical and Modern Physics has the fullest scope for enquiry and research.

It will take one too long to tell the entire story of the Atmosphere, nor is the story yet fully unfolded. I shall confine myself as far as possible to some of the happenings near the base of the atmosphere.

In presenting this report I have endeavoured to take the attitude or view-point of a Physicist in his rambles through some of the less frequented regions of Meteorology.

2. Solar Radiation

All physical, chemical and life processes on our earth are controlled by the sun and its radiation. Our little planet, with its gaseous envelope, revolving around the sun at a mean distance of 93,000,000 miles, intercepts less than 1/2,000,000,000 part of the radiation from the sun. The amount of radiation falling on a surface one square centimetre in area held normal to the sun's rays, outside the limit of the earth's atmosphere, is about 2 gram calories per minute.

The sun emits radiation like a black body at about 6000°A with the maximum intensity at about 0.5μ (5000 A.U.). In Fig.I the smooth curve A represents the distribution of energy J_λ in ergs per $cm.^2$ per second in solar radiation before it enters our atmosphere. The total energy under this curve is equivalent to 2 gr. cals.

When solar radiation passes through the atmosphere, it is depleted by the processes of (1) absorption by certain components of the air, (2) molecular scattering by air molecules and (3) scattering by dust and other impurities.

(a) *Absorption of Solar Radiation.*

Let us first consider absorption. The constituents of dry air are as given below,—

Gas.	*Density. (grammes per litre at N. T. P.)*	*Percent by volume*
Nitrogen	1.2506	78.03
Oxygen	1.4290	20.99
Argon	1.7837	0.94
Carbon dioxide	1.9769	0.03
Neon	0.9004	0.0012
Helium	0.1785	0.0004
Krypton	3.708	5×10^{-6}
Xenon	5.851	5×10^{-7}

The composition of the atmosphere, up to the heights for which data are available, is practically uniform. In addition to the above constituents of dry air, there is, of course, water vapour which decreases with height rapidly, becoming, according to Dobson and co-workers (Bakerian Lecture, 1945, Proc. Roy. Soc.), almost negligible above the tropopause, i.e., in the stratosphere and higher levels. Besides these, there is the small but very effective percentage of ozone in the upper atmosphere (in the region 10 - 50 K. M., with maximum content at 25 K. M. ; total ozone ranging from 1·5 to 4.5 mm. at N. T. P.), produced under the action of the ultra-violet radiation from the sun.

The constituents of the atmosphere which take a significant part in the absorption of the radiation from the sun are

(1) oxygen absorbing in the extreme ultra-violet, .12 to ·18 μ,

(2) ozone absorbing mainly in the ultra-violet region,

Hartley Band, .20 to $.33\mu$ and to a much smaller extent in the visible (Chappuis) Band, .44 to $.76\mu$,

(4) Water vapour absorbing in the near infra-red bands centred at ·93, 1·13, 1·42, and $1{\cdot}47\mu$ and

4) carbon-di-oxide in the near infra-red band at 2.7μ.

Coming back to the solar spectrum it will be seen from Fig.I that practically all the radiation in the ultra-violet region at wave-lengths smaller than $.33\mu$ (to the left of arrow marked B in Fig. I) is cut off by the oxygen and ozone in the upper atmosphere. In Fig.I the intense absorption band between .12 to $.18\mu$ due to oxygen and that due to ozone between .20 to $.33\mu$ are shown by the curves marked D and E. The ordinates of these curves are the decimal absorption coefficients defined by

$$I = I_0 \; 10^{-\alpha z}$$

where I is the intensity of radiation transmitted by a layer of absorbing gas z cm. in depth at N. T. P. and I_0 is the intensity before entering the layer. The relatively feeble absorption in the visible region due to ozone is not shown. On the long-wave side beyond. 68μ the solar spectrum shows a number of absorption bands due to O_2 and H_2O. Those due to water vapour at the wave-lengths $.93\mu$, 1.13μ, 1.42μ, and 1.47μ are quite conspicuous and cut off a signifcant percentage of the radiation from the sun in the near infra-red region.

From Fig.I it will also be clear that the absorption by CO_2 at 2.7μ will not affect the total radiation reaching the earth's surface materially.

It must be stressed here that the cutting off of the extreme ultra-violet by the ozone in the atmosphere is of immense significance to life on the surface of the earth ; we can tolerate these radiations only in minute doses,but any excess is very injurious. We shall revert to the significance of ozone in the upper air in regard to the thermal structure of the atmosphere and to the far infra-red radiation which it emits, later on in this report.

(b) *Scattering by the atmosphere and by dust*

The well known blue colour of the sky is due to the light diffused by the molecules in the air which scatter the shorter wave-lengths preferentially according to the well known inverse fourth power law of Rayleigh. Dust and water vapour in the atmosphere act more uniformly.

As discussed by P. Moon in a recent paper (Jour. Franklin, Instt. Nov., 1940) the transmission factor associated with atmospheric scattering is given by

$$T_{a\lambda} = 10^{-0.00380/\lambda^4}$$

(where λ is inμ), when the pressure is 760 mm. and the sun is at the zenith

$$T_{w\lambda} = 10^{-0.0075/\lambda^2}$$

when the sun's rays are vertical and the amount of precipitable water is 20 mm.

Similarly, when the dust content is of the order of 800 per cm.[3],

$$T_{d\lambda} = 10^{-0.0353/\lambda^{0.75}}$$

The combined transmission T_λ when the barometric pressure is p, precipitable water is w, and when the sun's rays are incident at an angle θ is given by Bouguer's equation

$$T_\lambda = \left[(T_{a\lambda})^{p/760} \times (T_{w\lambda})^{w/20} \times (T_{d\lambda})^{d/800} \right]^{1}$$

where in sec θ, the air mass (equal to 1 when $\theta = o$)

The above values of T_λ when corrected for the absorption by ozone provide the basis for the computation of the solar radiation which reaches the earth's surface , under known conditions of ozone, water vapour and dust content of the atmosphere in different seasons and at different latitudes. Owing to the paucity of actual radiation data, it has been considered worthwhile to undertake these computations for a number of latitudes over India. At present direct observations are available only for Poona and Shahjahanpur (for a few years). It is very desirable to collect them at more places in India.

3. Black-body Radiation from the Earth

Before discussing the effects produced by solar radiation incident on the surface of the ground,it will be useful to compare and contrast the blackbody radiations emitted by the Earth with that emitted by the sun.

The mean temperature at the earth's surface is only of the order of 300°A as compared to that of the sun which is about 6000°A. The blackbody radiation received from a body at 6000°A at the earth's distance from the sun, already shown in Fig. 1, is reproduced on a different scale in Fig. 2. as curve AA. The solar radiation is mainly confined to the visible region and tails off rapidly into a negligible quantity beyond say 3μ.

Curve B in Fig. 2 represents the black body radiation from a surface at 300°A (the earth's surface does emit like a 'black body'), drawn to the *same* scale as AA. Note that the maximum radiation occurs at $\lambda = 10\mu$ in the infra-red region and the total radiation is spread over the entire wave-length range extending from say 5μ to 30μ.

Curve B^1 shows the ordinates of curve B magnified 20 times. One essential fact to note is that little radiation is received from the sun in the infra-red region covered by curves B or B^1. The total *hemispherical radiation* σ T^1 emitted by each square centimetre of the earth's surface at the average temperature of 300°A is of the order of .669 gr. cals/cm.^{2}/mt. which is quite comparable to the direct radiation from the the sun, of the order of 2 gr. cals., at the upper limit of the atmosphere.

Let us now consider what happens to the thermal radiation emitted by the earth's surface. We have again to reckon with the water vapour present mainly in the troposphere (up to about 10 or 15 K. M.)., the carbon dioxide which occurs throughout the atmosphere at a concentration of .03% by volume and ozone which occurs in the layer 10 to 50 K. M. in the upper air, with a maximum concentration at about 25 K. M. (total ozone varies from 1.5 to 4.5 mm. at N. T. P. , depending upon the season, latitude and state of weather).

Water vapour has a large number of absorption bands. These are shown in the upper portion of Fig. 2 by the curve CC which shows the decimal absorption coefficent $\propto$ at the different wave-lengths. The strongest absorption is in the region 5.1 to 7.9μ and at wave-lengths beyond 15 or 16μ. Note that the region 8–12μ where water vapour is practically transparent occurs in the region of maximum black body radiation. We may collectively call the wave-length intervals of high absorption the S_3 region ($\propto > 10$), and the transparent range, $8-12\mu$, the S_1 region ($\propto < 1$). The remaining parts of the infra-red spectrum with partial or small absorption may be called the S_2 region.

In the upper portion of Fig. 2 are shown (*i*) the absorption bands at 4.3μ and 15μ of CO_2 and (*ii*) the $9.3-10.2\mu$ band of ozone.

The 4.3μ band of CO_2 may be left out of consideration as it occurs in a part of the spectrum where the energy of the black body radiation from the earth is relatively small. The strong CO_2 band centred at 15μ will, however, play a significant part in absorbing the earth radiation in that region of the spectrum. The absorption is very high in a relatively narrow band, but the fact that CO_2 is present throughout the atmosphere (total CO_2 content of the atmosphere is as large as 240 cm. at N. T. P.) should be remembered.

The ozone band at about 9.7μ occurs in a very important region of the infra-red spectrum, viz., in the region of maximum energy of the radiation and of maximum transparency of water vapour. The ozone region too occurs in the *upper* air.

4. The heat radiation from the sky : a brief review of work done in India

It will be obvious that the absorbing components like ozone, water vapour and carbondioxide in the atmosphere will absorb the direct radiation from the sun and the thermal radiation from the earth's surface in accordance with the respective magnitudes of their absorption coefficients and the relative intensities of the incident radiation in different parts of the entire spectrum. This is not all ; they will also emit heat radiation in the wave-lengths where they absorb, the intensity of this radiation being a function of the temperature and of the coefficient of absorption in accordance with Kirchhoff's law. Thus if E_λ is the intensity of radiation from a black body at wave-length λ and α_λ is the absorption coefficient of a layer of gas at the same wave-length, then the layer of gas will also emit radiation equal to $a_\lambda E_\lambda$. When the absorption is *complete*, then the layer will also emit like a perfect black body.

The importance of knowing the exact distribution of the absorption coefficients with wave-length throughout the range from the ultra-violet to the far infra-red end of the spectrum for the various gases and vapours present in the atmosphere, in order to evaluate the exact radiative equilibrium in different parts of the atmosphere can hardly be over-emphasised. Nevertheless, it must be confessed that our knowledge of the exact absorption coefficients is far from complete. As methods of absorption measurements improve from time to time, it is found that earlier measurements have to be rejected or considerably modified. In view of the great importance of this problem *it is time that the meteorologist himself organises a thorough investigation of the absorption spectra of the atmospheric gases at various pressures and temperatures.* Until recently it has been usual to assume that Beer's Law holds good under all conditions. Now, however, the diminution of the absorption coefficient as the pressure falls from that at sea level to the low pressures at higher levels in the atmosphere and the laws governing this decrease are receiving increasing attention.

Let us take, for example, the case of water vapour. As soon as we take account of the decrease with pressure of the absorption coefficients of the various infra-red absorption bands, it will be clear that the heat radiation emitted by the same amount of water vapour at 10 or 15 K. M. level will be much less than that emitted by the same amount of vapour at or near the sea level. Recent work has shown that the upper atmosphere above the tropopause contains little water vapour (Dobson). It would thus appear that the layers which can emit water vapour radiation towards the

ground should be well *within* the troposphere itself, the contribution of the higher levels being negligible.

The problems of radiative equilibrium in different parts of the atmosphere have engaged the attention of a number of workers in Europe, America and also in India. The subject is rather subtle and it would take considerable time and space fully to describe all that has been achieved so far. An excellent summary of the work done up to 1942 with full bibliography will be found in "Heat Transfer by Infra-red Radiation on the Atmosphere" by W. M. Elsasser (*Harvard University Studies*, No. 6).

From Elsasser's review it will be seen that the limit is being set to further progress mainly by the paucity of information regarding the absorption spectra of the gases concerned.

In India, investigations on the radiation from the atmosphere were commenced in 1930 at Poona by Ramanathan[73] who, about the same time, also gave us the first complete picture of the thermal structure of the earth's atmosphere [see Fig.3 (a)]. Ramanathan also carried out an investigation of the effect of radiation on the equilibrium of the higher layers of the troposphere and the nature of the transition from the stratosphere.[69] More recently, Karandikar[74] working under Dr. Ramanathan has carried out extensive measurements of the distribution of ozone in the upper atmosphere and discussed the effect of ozone, water vapour and carbondioxide on the absorption of the incoming solar radiation.

Ramanathan and Desai[66] discussed their measurements at Poona of the heat radiation from the night sky (1930-31) with an Angstrom's Pyrgeometer.

In a paper published in 1935 Ramanathan and Ramdas[18] discussed the physical basis for the various terms occurring in Angstrom's empirical equation, $\frac{S}{\sigma T^4} = A - B \times 10^{-\gamma e}$ and showed that this may be expressed also in terms of the S_1, S_2 and S_3 portions of the black body radiation at the temperature T°A in the form

$$\frac{S}{\sigma T^4} = (S_2 + S_3) - S_2 \times 10^{-6w}$$

where W is the total precipitable water in the atmosphere which is equal to 0.21 *e* according to Hann.

In the same paper they showed by computing a new set of absorption coefficients from the latest measurements of Weber and Randall (*Phys. Rev.* 1932, 40) that Hettner's earlier values are too high in the region beyond 11 μ. In another paper[68] the same authors discussed the possibility of extending the solar spectrum in the region 2200—2000A.

Malurkar[70] derived a theoretical expression of the radiation from the atmosphere and later[71,72] discussed the measurement of radiation with restricted apertures. He also derived a formula for nocturnal radiation and its relation to Angstrom's formula. Ramdas[25,26] Sreenivasiah and Raman discussed the variation of the radiation with zenith distance and the decrease of the radiation during the course of the night due to cooling of the air layers near the ground and its effect on the S_3 radiation.

Kohli[67] working at Poona and later Raman[27] have discussed their extensive measurements of solar radiation. Gadre[53] studied the absorp-

tion of solar radiation by water vapour in the atmosphere and estimated the total precipitable water W from his absorption measurements at the 0.93 μ absorption band.

Gadre has started work at Poona on the measurement of the heat radiation from the atmosphere in the ozone band at 9 to 10μ, a region where water vapour is transparent and emits no radiation.

Momin[55] working at Poona has developed an integrating solarigraph and a Cathode Ray Spectrograph for the direct observation of the absorption by water vapour and other gases in the atmsophere in the visible and near infra-red regions.

We have just referred here very briefly to the investigations made in India. For fuller information the original papers may be referred to. These investigations have received further impetus at the hands of the Atmospheric Research Committee which functions under the auspices of the *Board of Scientific and Industrial Research in India and it may be hoped that some of the gaps in our knowledge of the radiative properties of atmospheric gases will soon be filled.*

Our present picture of the Atmosphere.

Fig. 3(a) is the thermal structure of the atmosphere as given by Ramanathan in 1930. This picture has undergone little change in the light of later work. It may be noted that the tropopause is highest and the air temperature there lowest just above the equator.

Fig. 3(b) is the tentative picture of the atmosphere given by Dobson* recently. The probable variation of temperature up to the highest levels, based on all the available information, is suggested here. Note the cold tropopause, the rise of temperature with height (inversion) above the tropopause and the probable(?) continuation of this inversion up to the highest levels. Direct observation is confined to the first 30 K. M. or so. *Much remains to be achieved to confirm and amplify this picture.*

In the succeeding pages we shall see what happens at the base of our atmosphere which is comparatively easier to investigate, but which also presents a vast number of problems for investigation.

5. Phenomena near the ground

(a) *Solar Radiation : Insolation.*

Of all the factors which control the climate of the air and soil layers near the ground surface, the amount of solar radiation arriving at the surface after passing through the atmosphere, i.e., insolation, is the most important. It is only when we measure experimentally all the factors responsible for the disposal of the energy of solar radiation incident on the ground, that we shall get a real insight into the whole problem of thermal balance at the earth's surface.

Raman[27] working at the *Central Agricultural Meteorological Observatory* at Poona, has discussed the solar radiation measurements recorded with a Kipp and Zonen Solarigraph. On a clear day in summer the total energy received by a horizontal surface from the sun and the sunlit sky may

*Weather, Vol. 1, No. 2

be as high as 850 gr. cals. per square centimetre. Very recently Momin[55] also working at Poona, has developed an Electronic Integrating Solarigraph.

The surface of the ground is an 'active surface' as it absorbs solar radiation and thereby warms the air and soil layers near it [11, 29, 33, 49, 60] The darker the colour of the soil, the greater is the absorption of the solar radiation and the higher the temperature attained by the surface, the unabsorbed portion being actually reflected back to space. The percentage of solar radiation absorbed by some typical surfaces is indicated below,—

Nature of surface	% of solar radiation absorbed
French chalk (white)	0 (assumed 100% reflection)
Quartz powder (nearly white)	28
Sakrand soil (grey alluvium)	59
Grass covered soil (green)	68
Poona black cotton soil (nearly black)	84
Charcoal powder (black)	96

That the surface of the ground is the seat of warming by insolation by day and of cooling by radiation at night and that these heating and cooling tendencies are propagated *upwards* into the air layers and *downwards* into the soil layers can be seen from Fig.4. Curves are given here showing the variation of (1) air temperature with height above ground and (2) soil temperature with depth below the ground surface at 0600 hrs. (minimum temperature epoch), 0800 hrs., 0900 hrs., 1000 hrs., 1200 hrs.. and 1400 hrs. (maxi mum temperature epoch). The data were recorded above the bare plot of the Central Agri-Met Observatory at Poona on the 5th January 1933, a clear day with little wind.

We note that the diurnal range of temperature is equal to the horizontal distance between corresponding points on the curves O A B and OC D which represent the conditions at the epochs of *minimum* and *maximum* temperature, respectively. The diurnal range is *maximum* at the ground surface AC, about 37°C. It decreases in the soil very rapidly with depth, becoming practically negligible at a depth of 1 foot. At O, for example, the thermometer read 23.3°C at all hours of the day. (While the variation during a single day is negligible at 1 foot or more, the annual or seasonal variation becomes negligible only at much larger depths).

Coming to the air layers, the diurnal range of temperature falls rapidly in the first few inches above the soil surface, and more and more gradually at higher levels. Thus, even at 35 feet above ground, the diurnal range is of the order of 18°C (about half of that at the surface). In fact, the level in the atmosphere at which the diurnal variation becomes negligible is several kilometres above ground, so that a depth of 1 foot in the soil corresponds to a height of several thousand metres in the atmosphere so far as the decay of the diurnal range of temperature is concerned.

We now see why the ground surface is an "*active surface*" ; it is really the "*source*" of heating by day and of cooling during night.

(b) *Air temperatures at the maximum temperature epoch.*

Malurkar and Ramdas [1] indicated in 1930 that the rapid variation of air temperature in the first few centimetres above insolated ground, under the steady state prevailing at the maximum temperature epoch, may be represented by an expression of the type

$$\phi = \phi_0 \frac{\sinh \propto (h - z)}{\sinh \propto h}$$

where ϕ is the variable part of the temperature,
ϕ_0 is a constant,
h the thickness of the surface layer,
z the height to which ϕ refers and
∞ is a constant involving the constants of temperature radiation, convection and absorption by water vapour in the atmosphere.

The observed temperature distribution agreed fairly well with the above formula.

In two papers published about the same time Ramdas and Malurkar [2, 3] described a number of laboratory experiments which give an insight into the actual convective processes near a hot surface. Above the hot surface there is a dust-free or dark layer (observed under transverse illumination as in observing Tyndall phenomena) close to it. This dark layer shoots up as rising cones or filaments of hot air at a number of places which move about in a random manner. Between the rising currents of hot air, there are compensating downward currents of colder air from above. The dust-free layer below the plate is uniform and undisturbed. The phenomena *below the hot surface* have been extensively investigated by a number of workers in our laboratory and *this has led to a fuller understanding of "thermal repulsion", a molecular phenomenon.* [19, 20, 21, 23, 92, 56, 57, 58]. On the present occasion we shall confine our attention to the series of investigations "*above the plate*", which conforms to the meteorological problems.

On a clear afternoon the temperature is high at the soil surface (it can be as high as 75 to 80°C at the surface of the black cotton soil) and decreases very rapidly with height in the first few centimetres and more and more gradually as one moves to higher levels (see curve CD in Fig. 4). The lapse-rate (temperature gradient) is extremely high near the ground, often exceeding 200,000 times the adiabatic lapse rate (10° per K.M.) in the first centimetre or two above the ground. Like the air temperature, the lapse-rate too decreases rapidly with height.

The air in contact with the ground is warmer and therefore lighter than the air above. It, therefore, breaks through the colder air in the form of *rising* columns with compensating downward movements of the air from above, as indeed the laboratory experiments had shown. This gives rise to the well known shimmering of distant objects when observed through the air layers, an effect due to the variations of the refractive index in what we may call the "*shimmering layer*" *just above the hot ground.* Fig. 5 shows roughly a vertical section of the "shimmering layer". GG is the surface of the ground, the columns H, H are the rising currents of hot air, C, C are the descending currents of cold air and SS is the upper boundary of the shimmering layer. Above SS is the free atmosphere with the air layers moving horizontally and full of eddies. The eddying layer is also shown in

Fig. 5,. The effect of horizontal air motion or wind is to move as well as to incline the shimmer pattern in the direction of the wind. Even strong winds do not wipe out the shimmering layer during the day time when insolation is going on.

The partition SS is well defined at sunrise. Later, under the influence of insolation, the shimmering layer intensifies and thickens, lifting SS rapidly as the day advances. During this process, the partition SS becomes somewhat diffuse. At the maximum temperature epoch, the thickness of the shimmering layer is also maximum, Thereafter, this layer begins to contract towards the ground ,slowly at first, and more rapidly towards sunset. At the same time the partition SS lowers rapidly.

(c) *The minimum temperature epoch.*

This epoch represents the conditions after nocturnal cooling has progressed during the night. The processes involved in the nocturnal cooling of the ground and the air layers near it have been discussed in a series of papers based on experimental work carried out at Poona, during the past few years [1], [5], [6], [17], [18], [23], [24], [25], [26], [35], [51].—The ground surface emits heat radiation σT^4. At sunset insolation is withdrawn and the surface of the ground and the air layers near it begin to cool rapidly as a result of loss of heat by radiative exchange mainly with the water vapour, carbon dioxide, ozone and the dust content in the atmosphere. From observations made with an Angstrom's Pyrgeometer at Poona and elsewhere during clear nights, it has been found that

$$\frac{S}{\sigma T^4} = 0{\cdot}77 - 0{\cdot}28 \times 10^{-0{\cdot}074\, e}$$

where T is the temperature near the ground. e, the vapour pressure near the ground is really a function of the total water vapour content W of the atmosphere. (According to Hann W = 0.21 *e* approximately). Thus, when *e* is zero, *S has a minimum value of about half the outgoing blackbody radiation* σT^4 (which cannot be entirely accounted for as ozone and carbon dioxide radiation to the ground but may probably be attributed partly also to the radiation from the colloidal content of the atmosphere ; this aspect requires further investigation). When *e* becomes large, S has a maximum value of about threefourths of the outgoing blackbody radiation σT^4. Thus, nocturnal cooling on clear nights will depend on the water content of the atmosphere.

Coming back to the variation of air temperature with height during the minimum temperature epoch, it is found that the temperature decreases with height from the ground level up to 10 or 15 cm.

In Fig. 4 the curve AEB shows the variation of temperature with height during the clear season. The lowest temperature occurs at E as discussed in a number of papers from Poona. [4], [6], [7], [8], [18], [19], [51]. The layer AE with a lapse-rate is the remnant of the previous day's shimmering layer which persists during night whenever the winds are not strong enough to destroy it. Above this thin unstable layer we have the stable or stratified air layers associated with the well known inversion layers EB (Fig.4) where temperature *increases with height* Thus, after nocturnal cooling starts in the evening, we have the contracting shimmering layer supporting the stratifying inversion layer above. The fact that there is a reversal from *lapse* to *inversion* at the partition SS (Fig.5) enables one to locate it as a sharp or well-

defined partition at sunset and later during the night and until the next day's insolation begins to affect these air layers.

(d) *Temperature fluctuations and their variation with height above ground*

During day time when shimmering is going on vigorously, a sensitive temperature measuring instrument of sufficiently small size will sometimes be in a rising filament of hot air and sometimes in a descending current of cold air, so that its temperature will fluctuate about a mean temperature. The mean value of the temperature and the range of its fluctuation would both decrease with height above ground.

Using extremely small thermocouples of constantan-copper (45 gauge), one of them in a bath at a standard temperature and the other inserted in the position of the thermometer in an Assamann Psychrometer, connected to a sensitive Moll galvanometer with a period of 1/5 second, it has been possible to record practically instantaneous values of air temperature at intervals of a few seconds. After aspirating the psychrometer, a series of 50 readings was taken at 10 second intervals at various levels above ground up to 35ft. at the *Central Agri-Met Observatory at Poona*. After smoothing, so as to eliminate long-period or slow changes, values of (i) the mean temperature and (ii) the standard deviations of the short period fluctuations and (iii) the highest and the lowest temperature recorded at each of the levels was worked out. The values obtained at the maximum temperature epoch on the 6th January 1942,§ a typical clear winter day, are plotted in Fig. 6 the height being shown on a logarithmic scale for convenience. MM shows the mean temperature ; AA and BB show the mean temperature 'minus' and 'plus' the standard deviation, respectively. NN shows the lowest temperature and XX the highest temperature recorded at different levels. The rapid variation with height in the amplitude of the temperature variations is shown clearly by the curves. On plotting the standard deviation against the logarithm of the height it is found that the points fall practically on a straight line which cuts the height axis at a point corresponding to about 170 ft. above the ground. This shows that at the maximum temperature epoch the shimmering layer is likely to extend up to 150 or 200 ft. above ground.

Fig.7 shows the contrast between the variation of the mean temperature (curves at the top of the diagram) as well as of the short period temperature fluctuations with height at 1300 and 2200 hours respectively on the 22nd January 1945*. These curves show that under the turbulent conditions in the afternoon the short period fluctuations are very large near the ground, becoming rapidly smaller in amplitude above the 20 cm. level. At 2200 hours when the temperature increases with height (inversion) and the air layers are stratified, the fluctuations are comparatively small at all levels right from the ground surface. It is also interesting to note that at a level of 10 metres the short period fluctuations are small and similar in magnitude both by day and by night.

(e) *Turbulence in the air layers near the ground.*

We may, in passing, refer to some recent records of bi-directional wind-vanes† obtained at various levels above ground at the Central Agri-Met

* Recorded by Mr. A. U. Momin.

† Described in papers by F. J. Seraso and A. C. Best (London, Geoph. Mem. 52 1930 and 65, 1935). A few of these instruments were placed at my disposal through the courtesy of the Chemical Defence Research Establishment, Rawalpindi.

§ Recorded by Mr. P. K. Raman.

Observatory. The bi-directional wind-vane is actuated simultaneously by both the horizontal as well as the vertical fluctuations of wind direction. A pen attached to the arm of the vane traces the resultant movements of the vane on a piece of paper fixed to the recording drum at the base of the instrument. The 'scribbles' during 3 minute intervals of time recorded with the same instrument in quick succession at heights of 1½ ft., 3 ft., 4½ ft., 9 ft., 15 ft. and 35 ft. above ground at 1600 hrs., 1900 hrs., 2200 hrs., 0100 hr 0400 hrs. and 0700 hrs, during the period 1600 hrs. of the 14th to 0700 hrs. of the 15th May 1943 are shown in Fig. 8. The variation of temperature with height at the above hours is also indicated in the curves below the wind-vane records. At the bottom of the diagram is the anemogram (Dines P.T.) as recorded at the top of the 120 ft. tower of the Meteorological Office building at Poona. The points on the anemogram, to which the simultaneous records of temperature and wind direction refer are indicated by arrows.

The points to note in Fig. 8 are,

(i) in the afternoon, when the lapse-rate of temperature is high, there is considerable instability in the air layers near the ground and the amplitude of the oscillations in the wind direction increases rapidly with height (see records at 1600 hours)

(ii) when nocturnal cooling begins, convectional turbulence moderates and decreases with height rapidly when the stratification associated with inversion of temperature is fully established (see records at 0700 hours)

(iii) near the ground there is always a certain amount of frictional turbulence; nearest to the ground the 'scribble' has an elliptic envelope with the longer axis horizontal, due evidently to air movements being less restricted horizontally than vertically.

The records of Fig. 8 give a clear picture of turbulence in the air layer near the ground.

(f) *The nocturnal inversion layer near the ground.*

It will be appropriate to give here a brief account of the growth of the inversion layer towards and after sunset and during the night and of its destruction by the effects of insolation after sunrise, during clear weather.

The nocturnal inversion layer begins forming some time before actual sunset. Its lower boundary merges into the upper boundary SS (Fig.5) of the shimmering layer. When the inversion layer starts forming, simultaneously, the shimmering layer indeed approaches the ground rapidly about sunset and within a short time after sunset attains its *minimum* height, say about a foot or so above ground; thereafter, it remains at this level more or less during the rest of the night and until insolation sets in next morning. The transition between the developing inversion and the upper boundary of the shimmering layer is a region of *zero gradient* of temperature and it may be called the '*lower isothermal layer*'. This isothermal layer moves *downwards* in the evening about sunset and *upwards* in the morning after sunrise.

The Poona data, being confined to the first 35 ft. above ground, are insufficient to indicate what happens to the upper boundary of the inversion layer. We may for this purpose utilise the data recorded and discussed by N. K. Johnson and G.S.P. Heywood (London, Geoph. Mem. No. 77),

These data, recorded at Leafield, refer to heights of 1.2, 12.4, 30.5, 57.4, and 87.7 metres above ground and therefore leave out of consideration the details of the shimmering layer, but are very valuable for following the movement of the upper boundary of the inversion layer. From their curves of temperature variation with height at different hours of the day in different months of the year, it is easy to estimate the position of the upper boundary of the inversion layer at different hours starting some time before sunset when the inversion begins to develop and ending some time after sunrise when the inversion is destroyed. The information so obtained is given below for the months of January, April, July and October.

Growth of the inversion layer.

Month	The height of the upper boundary of the inversion layer in metres at the hours (G.M.T.) noted below.																				
	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10
January	7	10	25	50	57	61	59	70	67	70	greater than 88 metres.										
April					20	28	35	37	42	57	67	greater than 88 metres.									
July						16	30	44	48	50	58	57	70	73	75						
October			20	30	38	43	55	58	59	60	62	68	greater than 88 metres								

It is obvious that the inversion layer continues to grow in thickness until insolation starts next morning. The *upper boundary* of the inversion layer merges into what may be called the '*upper isothermal layer*' above which there exists a layer with a lapse or decrease of temperature with height. Thus the inversion layer near the ground is formed between two layers of lapse, one of which, the lower one, is the remnant of the shimmering layer and the other is the free atmosphere above in which also temperature decreases with height.

Figs. 9 and 10 have been constructed with the help of the Poona data and those referred to above, to show the *development* and the *destruction* respectively of the inversion layer. In both these figures the ordinates represent height above ground (logarithmic scale) and the abscissae temperature. The temperature-height curves are intended to show the nature of the variations which set in before, during and after sunset (Fig.9) and just before, during and after sunrise (Fig.10).

Fig. 9 : *Development of inversion.*

Curves 1, 2, 3, ..., 10 represent the vertical thermal structure at different times. As the temperature decreases with time at all levels, the time sequence is from right to left. Curves 1 and 2 show the thermal structure before the formation of the inversion layer. Some time before sunset, when the inversion is about to commence, the upper limit of the shimmering layer is at the point O. As soon as nocturnal cooling starts, the inversion starts developing. Its lower boundary which is the '*lower isothermal layer*'', approaches the ground rapidly from O to B within a short while after sunset and thereafter remains more or less steady at about

1 ft. or so above ground as BC*. The upper boundary of the inversion layer starting at O begins to rise rapidly at first and more and more gradually thereafter as OA in the figure. AOBC is the inversion region in the diagram. OA and OBC are in the upper and lower isothermal layers respectively. Below OBC we have the lapse of the shimmering layer and above OA the lapse of the free atmosphere.

Fig. 10 : *Destruction of Inversion.*

Curves 1, 2, 3 and 4 represent the thermal structure at different times before and after sunrise. As the temperature increases with time, the time sequence is now from left to right. The inversion region is AO′BC. AO[1] is the upper boundary of the inversion layer in the morning and it remains more or less steady at the same level during the process of destruction of the layer. CB represents the base of the inversion layer early in the morning. As soon as insolation begins at the point indicated by the vertical arrow (sunrise), the shimmering layer thickens very rapidly from B to O′. As soon as its upper boundary reaches the point O′ the inversion layer is completely obliterated.

The above details are very interesting. In particular it may be noted that when the inversion starts forming in the evening, it does so *not from the the ground* as used to be supposed, *but from the level represented by the point O in fig.* 9. The lower boundary of the inversion layer comes towards the ground but not quite in contact with it while the upper boundary moves upwards and continues to do so until sunrise on the next day.

The above complete picture of the growth and destruction of the thermal inversion layer near the ground has been given *for the first time as a result of our work at Poona* and is based mainly just on the temperature readings with an Assmann psychrometer at short height intervals at different times of the day.

(g) *Correlation between vertical gradients of temperature and wind velocity.*

We have studied in detail ([50]) the correlation between the gradients of temperature and wind velocity at different time intervals during the day, at different height intervals and at different seasons with the help of the simultaneous observations of temperature and wind recorded at the Central Agri-Met Observatory.

The variation of wind velocity 'u' with height 'z' above ground may be represented by

$$u = u_0 z^{1/n}$$

where u_0 and n are constants. If u_1 and u_2 are the wind velocities at the levels z_1 and z_2 it is obvious that

$$n = \frac{\log z_1 - \log z_2}{\log u_1 - \log u_2}$$

*During nights with moderate to strong air movement the shimmerihg layer may be entirely wiped out ; such nights are very rare during the winter season.

Values of n so obtained have been correlated with values of λ the lapse rate between corresponding levels. The correlation coefficients for the various height intervals are given below :

Height interval	Correlation between n and λ
2 – $3\frac{1}{2}$ ft.	– 0.34
$3\frac{1}{2}$ – 6 ft.	– 0.59
6 – 12ft.	– 0.55
12 — 20ft.	– 0.41
20 – 35ft.	– 0.71

All the above values are significant. It may be pointed out that when *n* is high the wind velocity increases with height less rapidly than when *n* is low. High values of n are associated with turbulence and vigorous mixing and high lapse-rates or negative gradients of temperature (day time). Low values of n are associated with stability and inversions of temperature (night time). The correlation between n and λ is high and increases generally with height. This is not surprising when one remembers that it is the *same entities* (shimmer filaments or eddies) which are responsible for the vertical transfer (by conductive processes) of momentum, heat, etc. in the atmosphere. For full particulars the original paper may be referred to.

(h) *Variation in the time of occurrence of the maximum temperature epoch.*

The maximum temperature epoch is at or immediately after noon at the soil surface. It occurs later and later as one moves away from the ground. As is well known, the equation of heat conduction in any medium is given by

$$\frac{d\theta}{dt} = K \frac{d^2\theta}{dz^2}$$

where θ is the temperature and K is the thermal diffusivity (conductivity divided by product of density and specific heat) of the medium. In experiments on the heat conduction of gases, a thin slab of air is enclosed between two surfaces and *great care* is taken to eliminate convection by keeping the upper plate hot and the lower one cold. The heat conductivity of air under the conditions when heat is transported only by molecules is 5.5x 10^{-5} corresponding to a diffusivity equal to 17. The meteorologist dealing with the problem of heat conduction through the air layers over warm ground considers that the same equation should hold good when K is taken to be the eddy-conductivity, the eddies playing the same role as molecules do in molecular heat conduction. Eddy diffusivity may be estimated in the usual manner, from the lag between the times of occurrence of the temperature epoch at two levels z_1 and z_2. We have

$$z^2 = 4\ Kt$$

where at height z the maximum temperature occurs t seconds later than at the ground. When the above equation is applied to the lag in the *free atmosphere,* the values of K are found to be of the order 100 or 1000 or more times the molecular value. It is usually considered that K the eddy diffusivity should have as its limiting value the molecular diffusivity as one approaches sufficiently close to the ground surface.

From our measurements at short height intervals like 0, 2, 5, 10, 15 etc. cm., we find that *in the shimmering layer*, at any rate, the time lag of the maximum temperature epoch is much larger than should be the case if the conduction close to the ground surface was truly molecular. There is often more than half an hour's lag between 0 and 1 or 2 cm. and more than 10 to 30 minutes' lag between 1 or 2cm. and say 10 cm. Calculating from these values *K comes out of the order of* 1/10 *to* 1/100 *th of molecular diffusivity.*

The parts played by radiation and the distorted non-horizontal distribution of the isotherms in a shimmering layer (where hot air filaments shoot upwards bodily and cold air currents come down) in bringing about the above high values of 'lag' and 'low' values of K are being examined.

(i) *The transmission of heat by convection from the insolated ground to the atmosphere.*

The transfer of heat from the ground to the air layers above takes place mainly during the day, when the surface is warmer than the air. Raman [15] working at the Central Agri-Met Observatory at Poona has developed a simple instrument for measuring this heat loss by the ground. The general arrangement is shown in Fig. 11. A thin polished silver-plated constantan strip AB is mounted between the ends of a pair 'of nickel-plated and polished copper rods carried on a base of ebonite. The copper rods are connected to the terminals C and D. One junction P of a copper-constantan thermocouple is placed in thermal contact with the strip AB. The other junction Q is suitably mounted on silk fibres so that it can be placed in contact with the surface of the ground. The underside of the strip AB is lined with a layer of cork so that ,when placed on the ground, it is thermally insolated from it. R and S are terminals for connecting the thermocouple to a sensitive galvanometer. The strip AB can be heated electrically as required and the current measured on a calibrated ammeter. The convection apparatus is exposed on the open ground while the battery and electrical instruments are housed in an adjoining hut.

The measurement of the heat loss from the ground is made by adjusting the electric current through AB so as to equalise the temperatures of P and Q. This is indicated by zero deflection in the galvanometer. Knowing the electrical resistance and area of AB and the coefficients of absorption and emisson of radiation by the strip in the visible and the infra-red regions of the spectrum, it is easy to calculate the heat loss by convection. Fig. 12 shows the hourly variation of the heat loss by convection, wind velocity and the temperatures at surface and 4 ft. levels respectively on a clear day. The total loss during the day is of the order of 175 gr.cals. The heat loss increases from 175 in February to 340 calories in summer.

(j) *The exchange of water vapour between the soil and the air layers above it.*

A considerable amount of work has been done at Poona on this topic. Ramdas and Katti have shown in a series of papers [10, 12, 13, 14, 28, 30]) that when soil samples containing only hygroscopic moisture are exposed in the open they *lose* water by evaporation from the morning up to the maximum temperature epoch in the afternoon. Thereafter, towards the evening, during the night and until sunrise nest morning, the soil reabsorbs the water vapour from the atmosphere. Once the soil has reached the hygroscopic stage, there is a diurnal variation but no day to day variation in the mean weight of the soil sample. Fig. 12 (a) shows the isopleths of soil moisture (% on dry basis) during the period August 1935 to October 1936. In the

upper portion of the diagram the rainfall amounts are also indicated in inches. It may be noted that the soil surface dries up rapidly after October, the moisture percentage at the surface being of the order of 5% only during the dry season. This phenomenon of evaporating water vapour into the atmosphere during a part of the day and re-absorbing an equal amount during the rest of the day is actually going on in the soil under natural conditions during the dry season when the top layer of the soil contains only hygroscopic moisture.

Soils vary in their capacity to lose and gain water vapour in the above fashion. Fig.13 shows the hourly variations in the weights of some typical soils of India when exposed flush with the soil surface at the Central Agri-Met Observatory at Poona. The mean weight of the soil samples was of the order of 60 gr. spread over 12.6 sq. cm. in glass dishes. The diurnal variation is maximum in the black cotton soils, the red soils having a moderate variation and the alluvial soils only a fifth of the efficiency of the black soils.

There is a complementary phenomenon going on in the air layers near the ground. During day time there is an *upward* flow of water vapour from the ground with vapour pressure *decreasing* with height. During night time there is a downward flow of water vapour towards the ground which desiccates the air . The vapour pressure then increases with height above ground. This phenomenon goes on day after day during the dry season. The variation of vapour pressure with height at the epochs of maximum and minimum temperature is given below for the month of January(average values for 1933-37).

Height above ground	Vapour pressure in mm. of Hg. at the Maximum temperature epoch	Minimum temperature epoch
0·3″	8·6	5·9
1·0″	8·2	6·0
3·0″	8·0	6·0
6·0″	7·8	6·1
1 ft.	7·7	6·2
2 ft.	7·6	6·4
3 ft.	7·5	6·6
4 ft.	7·5	6·8
6 ft.	7·4	7·1
8 ft.	7·4	7·1
10 ft.	7·3	7·4

The investigations on the exchange of moisture between the soil, plant materials, etc., have been continued by Ramdas and Mallik and discussed by them in a series of papers[30, 31, 32, 35].)

It may be mentioned that a fraction of the heat gained by the soil by absorbing solar radiation is used up in evaporating moisture from the soil, but an equal amount of heat is returned to the soil surface when water vapour is re-absorbed.

6. The thermal balance at the ground surface

The factors which control the thermal balance at the surface of the ground during clear weather may be grouped under (a) Radiation., (b) Convection, (c) Conduction and (d) Evaporation.

(a) *Radiation.*

(i) Visible radiation coming from the sun and the sunlit sky is incident on the ground. The amount of this incoming energy is estimated from solarigraph records. If the albedo of the soil is known, the fraction actually absorbed by the soil surface and converted into heat can be calculated.

(ii) Water vapour and other absorbing components of the atmosphere are emitting heat radiation towards the ground both during day and night. The quantity of energy received by the ground is measured with a Pyrgeometer.
(iii) The surface of the ground is continuously emitting radiation as a black body. This is equal to σT^4_s where T_s is the surface temperature at any instant. From continuous (hourly) records of T_s it is possible to compute the total radiation emitted by the surface during the day.

(b) *Convection.*

The method of measuring the convective heat loss from the ground has been described in Section 5(i). This loss mainly occurs during the day time when the surface temperature is appreciably higher than that of the air in contact with it. During night time the loss of heat by convection from the ground is almost negligible.

(c) *Conduction.*

During the day time when the soil surface is warmer than the layers below, there is a flow of heat from the surface downwards. During night when the interior of the ground is warmer than the soil surface there is a return flow of heat to the surface. If θ_0 and θ_1 are the mean temperatures during an hour at the surface and 1 cm. below it, the heat conducted into the lower layer. through the 1st centimetre layer with a mean temperature θ_m will be $K(\theta_0-\theta_1)$ per unit time per sq. cm. when K is the soil's heat conductivity. If the unit layer is itself changing in temperature at the rate $\frac{d\theta_m}{dt}$ the accumulation of heat in the unit layer itself will be $C\frac{d\theta_m}{dt}$, C being the specific heat of the soil. Therefore the amount of heat conducted from the soil surface will be $K(\theta_0-\theta_1) + C\frac{d\theta_m}{dt}$. Using appropriate signs for $\theta_0-\theta_1$ and $\frac{d\theta_m}{dt}$ and knowing θ_0, and θ_1 and θ_m from curves showing the hourly variation of these temperatures, it is easy to compute the heat leaving or arriving at unit area of the soil surface during different hours of the day.

(d) *Evaporation and Condensation.*

The amount of water lost by evaporation from the Poona soil in the day time during the dry season is of the order of 0.03 gr. per sq cm. ; but a more or less equal quantity of water vapour is reabsorbed from the atmosphere during the rest of the day. Thus about 20 gr. cals. of heat are spent in evaporation but the same quantity is delivered at the surface during the re-absorption.

The table below gives a statement of the thermal balance at the ground surface at Poona on the 23rd April 1936.

Gain (gr. cals. per sq. cm.)		Loss (gr. cals. per sq. cm.)	
Radiation received from the sun and sunlit sky during day, after correcting for absorption factor at 84%	655	Temperature radiation from ground	950
Heat radiation from the atmosphere at 0.48 gr. cals. per $cm.^2$ per minute	691	Convective heat loss	350
Heat gain during absorption of moisture	20	Heat transfer by conduction (difference between loss by day and gain by night)	35
		Heat used up in evaporation by day	20
Total gain	1,366	Total loss	1,355

There was a small carry over to the next day, of the order of 11 cals. *The above statement is based entirely on experimental determinations of the various factors.*

7. The Micro-climates of Plant Communities

Investigations [7, 8, 9, 37, 52] carried out at Poona show that plant communities tend to develop their own characteristic local or *micro-climates* which deviate from the climate of a neighbouring open space to the extent that the horizontal air movement and the incidence of solar radiation on the ground are cut off by the stand of the crop. The state of the ground, whether wet or dry, also plays its part. Fig. 14 shows curves of air temperature and vapour pressure at 2 P.M. on the 9th October 1934 in a number of environments at different levels above ground. We have at one end curve A representing the extreme conditions in the open with a rapid fall of temperature with height. At the other end we have the irrigated sugarcane crop in which the temperature is low near the ground and increases with height as in a nocturnal inversion.

More recent work at Poona has shown that inside the sugarcane crop the almost continuous canopy formed by the upper portion of the crop in the later stages of growth acts like an *'active' surface*, somewhat like the ground in the open, so that, during day time the canopy gets warmer than the ground below. The inversion so formed has been designated as a *'forced inversion'* and has been fully described in a recent paper [51]. Fig. 15 shows the air temperature and vapour pressure inside a sugarcane crop.

The micro-climates of plant communities, their variations with the age and density of the crop etc, are of great interest to the agriculturist, the botanist and the ecologist. *I would, however, reserve discussion of these topics to a later occasion.*

8. Problems of Hydrology : Rainfall, Evaporation Soil Moisture, etc.

A brief review of India's Rainfall has been presented in a recent report by the speaker [75]. India's liability to 'droughts' and floods' is indicated by Fig. 16.

The Agricultural Meteorology Section at Poona has been engaged, amongst other activities, in investigating the movement of moisture through the soil, evaporation from free water and soil surfaces, effects of certain salt on the permeability of soils to water etc. [34, 10, 41, 42, 43, 44, 45, 46, 47, 48, 50] These investigations have been summarised in a recent report by me presented to the Research Committee of the Central Board of Irrigation in July last [76].

There are first of all the problems connected with the 'evaporating power' of the air layers near the ground. This factor is usually measured with tank evaporimeters and can be correlated with the evaporation losses of big reservoirs, lakes, etc., if the essential comparative observations are recorded earlier.

Secondly , we have the problems relating to the fate of 'rainfall' or 'irrigation'. The controlling factors here are

(1) evaporation from the soil surface,
(2) surface drainage,
(3) percolation through the soil,
(4) retention by the soil and
(5) underground drainage, if the soil is resting
on an impervious layer of rock or other materials.

The evaporation from the soil surface is comparable in magnitude to that from a free water surface so long as the soil surface is saturated with water. When the soil dries up, the evaporation will depend also on the upward or capillary ascent from the wetter soil below ; and when this supply also diminishes, the soil surface begins to exchange water vapour with the air layers above in the manner described in a previous para of this report. From observations made at Poona with a series of soil evaporimeters with depth of wet zone below soil surface ranging from 6″ to 3 ft., it is found that for any soil, E_z , the evaporation when the wet zone is z cm. below soil surface, can be expressed as

$$\frac{E_z}{E_0} = 10^{-\infty z}$$

where E_0 is a constant representing the evaporation when the wet zone is up to the soil surface itself and $\propto$ is another constant.

Measurements with different types of soil to calculate their $\propto/\mu o$ ·fficients are in progress. With the help of these coefficients it will be possible to estimate the evaporation losses from extensive catchments in different seasons when z is known.

We have investigated the upward movements of salts in association with the capillary ascent and subsequent evaporation from the soil surface. The effect of certain salts like sodium carbonate on the black cotton soil in causing swelling of the colloidal fraction of the soil, choking up the pore space, and consequently decreasing the permeability of the soil has also been extensively investigated. These results are discussed in a series of papers [30], [31], [34], [35], [42], [43], [54], [46], [47], [77], [78] by Ramdas and Mallik.

Momin ([59]) working at Poona has recently designed a simple instrument for recording soil moisture in situ, by noting the time taken for raising the temperature of a soil thermometer in the field by 5°C when an electric current is passsd through a heating coil, surrounding the thermometer bulb. Calibration over a season is all that is needed for using this instrument thereafter to read off the soil moisture %. This takes only a few seconds, as compared to the days spent in the usual method of estimating by sampling.

The effective rainfall instrument ([76]) is another very useful device that has been developed at Poona for recording the fraction of the rain water which is (i) held by the soil, (ii) drained through a known depth of soil and (iii) lost by evaporation.

The problems of hydrology are many and often complicated, but we hope to play our role by devising the necessary experimental methods and techniques.

9. Conclusion

I had a wide choice of subjects to talk about today. I have omitted many items and touched upon a few selected topics which might be of interest to Physicists. I have not said anything about weather forecasting daily, weekly and seasonal, about cyclones and depressions which cause wide-spread devastation, about sunspots and weather, cosmic rays in relation to atmospheric factors, about oscillations in the atmosphere, atmospheric electricity, theories of rain-drop formation, etc., etc. I am sure that meteorologists who may have occasion to preside over your section in later years will do ample justice to some of these topics.

May I say how grateful I am to have had this opportunity of telling you something about the activities of a physicist who strayed into meteorology? If what I have said has served to create some interset in atmospheric problems in some of you, I shall feel amply rewarded. Thank you for your patient hearing.

References.

1. Malurkar, S. L. and Ramdas, L.A. (1931). Ind. J. Phys. 6,495.
2. Ramdas, L.A. and Malurkar, S.L. (1932). Ind. J. Phys. 7,1.
3. Ramdas, L.A. and Malurkar, S.L. (1932). Nature, 6, 201.
4. Ramdas, L.A. and Atmanathan, S. (1932). Ger. Beit. Zur Geophysik, 37,116.
5. Ramdas, L.A. and Atmanathan, S. (1933). Sci. Notes, V. No. 54.
6. Ramdas, L.A. (1934). Curr. Sci., II (11), 445.
7. Ramdas, L.A., Kalamkar, R.J. and Gadre, K.M. (1934). Ind. J. Agri. Sci.,IV, (3).451

8. Ramdas, L.A., Kalamkar, R.J. and Gadre, K.M. (1935). Ind. J. Agri. Sci. V, (1), 1.
9. Kalamkar, R.J. (1934). Cur. Sci. III, (2). , 80.
10. Ramdas, L.A. and Katti, M.S. (1934). Cur. Sci. ,III, (1), 24.
11. Ramdas, L.A. and Dravid (1934). Cur. Sci., III, (6). 226.
12. Ramdas, L.A. and Katti, M.S. (1934). Ind. J. Agri. Sci. IV, (6), 923.
13. Ramdas, L.A. and Katti, M.S. (1935). Cur. Sci. III, (12), 612.
14. Katti, M.S. (1935). Cur. Sci., IV, (6), 419.
15. Raman, P.K. (1936). Proc. Ind. Acad. Sci. III, (2), 98.
16. Ramdas, L.A. (1935). Cur. Sci. III, (3), 325.
17. Raman, P.K. (1935). Proc. Ind. Acad. Sci. I, (11), 815.
18. Ramanathan, K.R. and Ramdas, L.A. (1935). Proc. Ind. Acad. Sci. I, (11).822.
19. Ramdas, L.A. and Paranjapo, M.K. (1936). Cur. Sci. IV. (9). 642.
20. Paranjapo, M.K. (1936). Proc. Ind. Acad. Sci., IV, (4), 423.
21. Paranjapo, M.K. (1936). Proc. Ind. Acad. Sci,. IV, (6), 639.
22. Ramdas, L.A. (1937). Jour. University of Bombay,. VI, (2), 18.
23. Ramdas, L.A. Sreenivasaiah, B.N. and Raman, P.K. Proc. Ind. Acad, Sci, .V, (1),45.
24. Raman, P.K. (1936), Proc. Ind. Acad. Sci., IV, (2), 243.
25. Narasimhan, M and Ramdas, L.A. (1937). Ind. J. Agri, Sci., VII, (5), 745.
26. Ramdas, L.A. Sreenivasiah, B.N. and Raman, P.K. (1939). Proc. Ind. Acad. Sci.. IX, (5), 386.
27. Raman, P.K. (1938). Memoirs Ind. Met, Dept. 26, (8), 151.
28. Ramdas, L.A. and. Katti, M.S. (1936). Ind. J. Agri. Sci. ,VI, (6), 1163.
29. Ramdas, L.A. and Dravid, R.K. (1936). Proc. Nat. Inst. Sci., III, (3), 131.
30. Ramdas, L.A. and Mallik, A.K. (1938). Cur. Sci., VI, (9), 452.
31. Mallik, A.K. (1939). Ind. J. Agri Sci. IX, (3), 457.
32. Ramdas, L.A. and Mallik, A.K. (1939). Cur. Sci. VIII, (4), 164.
33. Dravid, R.K. (1940). Ind. J. Agri. Sci., X, (3), 352.
34. Ramdas, L.A. and Mallik, A.K. (1939). Cur. Sci., VIII, (6), 264.
35. Mallik, A.K. (1940). Ind. J. Agri. Sci., X, (2), 164.
36. Ramdas, L.A. (1938). Bioklim. Beib. I, 30.
37. Raman P. K. (1941), Ind. Sci. Congress.
38. Ramdas, L.A. (1940). Ind. Farming, I, 11 531.
39. Ramdas, L.A. and Joglekar, S.Y. (1941). Proc. Ind. Acad, Sci., XIII, (5), 374.
40. Ramdas, L.A. Mallik, A.K. and Gadre, K.M. (1941). Ind. Sci. Congress.
41. Mallik, A.K. (1941). Ind. Sci. Congress.
42. Mallik, A.K. (1942). Ind. J. Agri, Sci., XII, (4), 648.
43. Ramdas, L.A., Mallik, A.K. and Pandit, U.P. (1942). Cur. Sci. XI, (7), 288.
44. Sreenivasan, P.S. (1942), Cur. Sci. XI, (7), 287.
45. Ramdas, L.A. and Mallik, A.K. (1943). Proc. Ind. Acad. Sci. XVI, (1), 1.
46. Ramdas, L.A. and Mallik, A.K. (1942). Proc. Ind. Acad. Sci. XVI, (1), 16.
47. Ramdas, L.A. and Mallik, A.K. (1944). Cur. Sci. ,XIII, (2), 42.
48. Momin, A.U. (1944). Proc. Ind. Acad. Sci., XIX, (2), 100.
49. Ramdas, L.A. (1943). Ind. Met. Dept., Tech. Note 3.
50. Ramdas, L.A. (1944). Ind. Met. Dept. Tech. Note 9.
51. Ramdas, L.A. (1945). Ind. Met. Dept. Tech. Note 21.
52. Ramdas, L.A. (1946). Ind. Ecologist, I, (1), 1.
53. Gadre, K.M. (1946). Proc. Ind. Acad. Sci. XXIII, (3), 115.
54. Narayanan, A. (1946). Ind. Sci. Congress,.
55. Momin, A.U. (1946). Ind. Sci. Congress.
56. Paranjape, M.K. (1944). Cur. Sci., XIII, 3. 1,
57. Paranjape, M.K. (1946). Proc. Ind. Acad. Sci., XXIII, (5), 233.
58. Ramdas, L.A. and Raman, P.K. (1946).. Proc. Ind. Acad. Sci. XXIII, (3), 127.
59. Momin, A.U. (1946). Appearing shortly in the Ind, J. Agric, Sci.
60. Ramdas, L.A. (1946). Ind. Sci. Congress.
61. Gadre, K.M. and Narayanan, A, (1939). Q.J. R. Met. Soc. ,LXV, (281), 450.
62. Raman., P.K. (1942). Cur. Sci. ,XI, (6), 231.
63. Misra, R.K. (1944). M.Sc. Thesis submitted to the Univ. of Nagpur.
64. Mallik, A.K. (1946), Ind. Ecologist, I, (1), 55.
65. Misra, R.K. (1946). Ind. Sci. Congress.
66. "Heat Radiation form the night sky at Poona"by K.R. Ramanathan and B.N. Desai Gerl. Beit. Z. Geophys. Vol. 35, 1932.
67. "Solar radiation measurements at Poona in 1931" by S.S. Kohli, Memoirs Ind, Met. Dept., Vol. 25, part 10.
68. "The transparency of the atmosphere in the ultra-violet and possible means of extend ing the solar spectrum in the regions 2200-2000 A" by K.R. Ramanathan, and L.A. Ramdas. Proc. Ind. Acad. Sci., Vol. I, No. 5, 1935.
69. "Effect of radiation on the equilibrium of the higher layers of the troposphere etc., etc.," by K.R, Ramanathan, Beitr, Z. Phys, d. freien atm., 18, 196, 1932,

70. Malurkar, S. L. Gerl.Beitr. Z. Geophys 1932, 37, p. 410

71. "A note on measurements of atmospheric radiation with restricted apertures" by S.L. Malurkar. Gerl. Beit,. Z. Geophys,. 44, 127, 1935.

72. "Derivation of a formula for nocturnal radiation and its relation to Ångstrom's formula" by S.L. Malurkar, Gerl. Beit, Z. Geophys. 47,357, 1936.

73. Ramanathan., K.R., Nature, June 1929, p, 834,

74. Karandikar, R.V. Proc. Ind. Acad. Sci. Vol. 23., 1946.

75. "Rainfall of India- A brief Review" L.A. Ramdas, Empire Journal of Experimenta Agriculture, Vol. XIV. No. 54, 1946.

76. "Report of Soil Moisture and Evaporation Investigations being conducted by the Agricultural Meteorology Section at Poona" by L.A. Ramdas, communicated to the Research Committee Meeting of the Central Board of Irrigation, July 1946.

77. Ramdas, L.A. and Mallik, A.K. Cur. Sci. June, 1947, 16, 172-173.

78. Ramdas, L.A. and Mallik, A.K. Proc. Ind. Acad. Sci. ,Vol. 26, 1947.

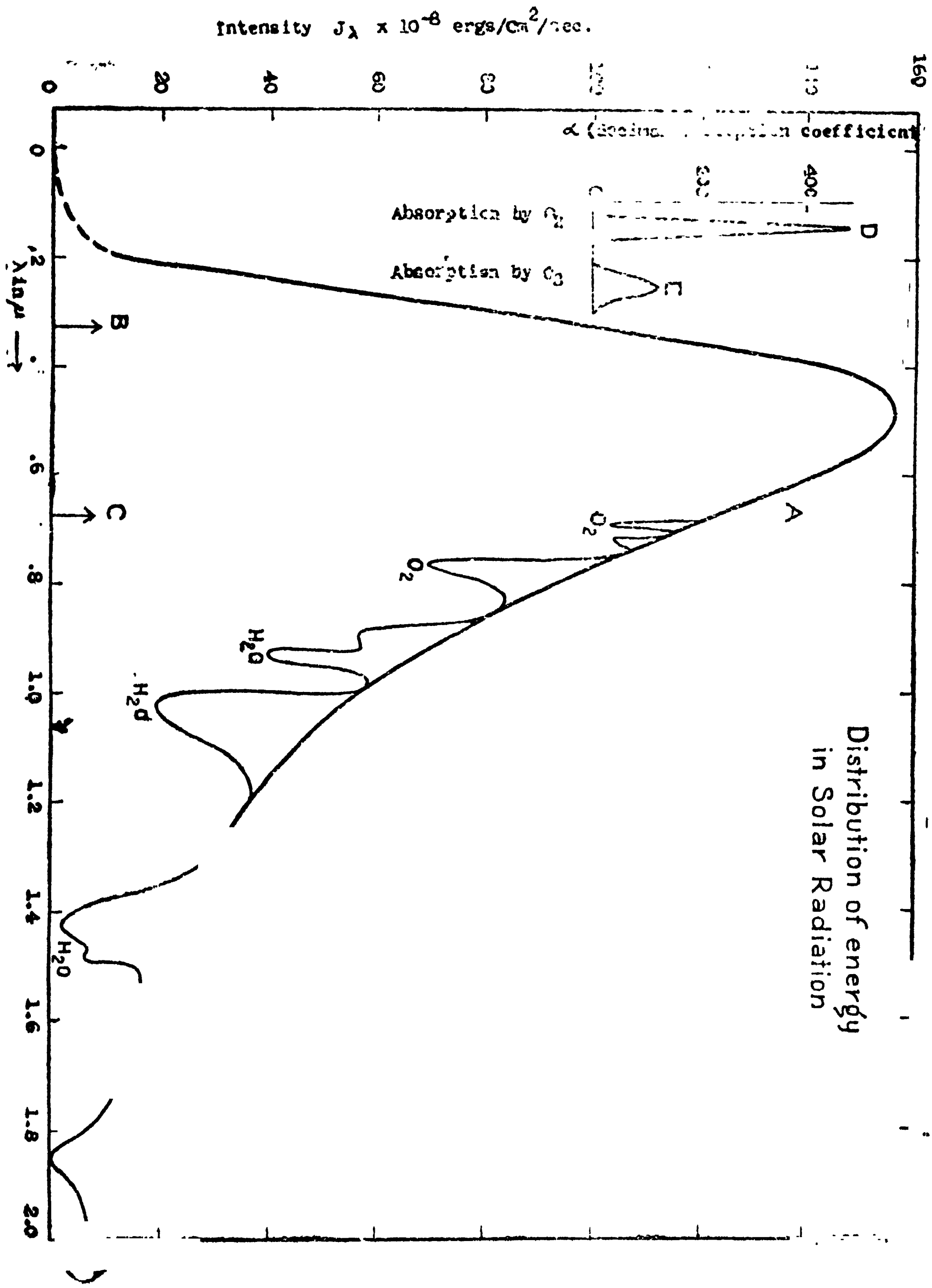

Intensity Jλ x 10-8 ergs/Cm2/sec.
Distribution of energy
in Solar Radiation
Absorption by O2
Absorption by O3
coefficient
A
B
C
D
E
O2
O2
H2O
H2O
H2O
λ in μ
0
.2
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
0
20
40
160
400

Fig. 1

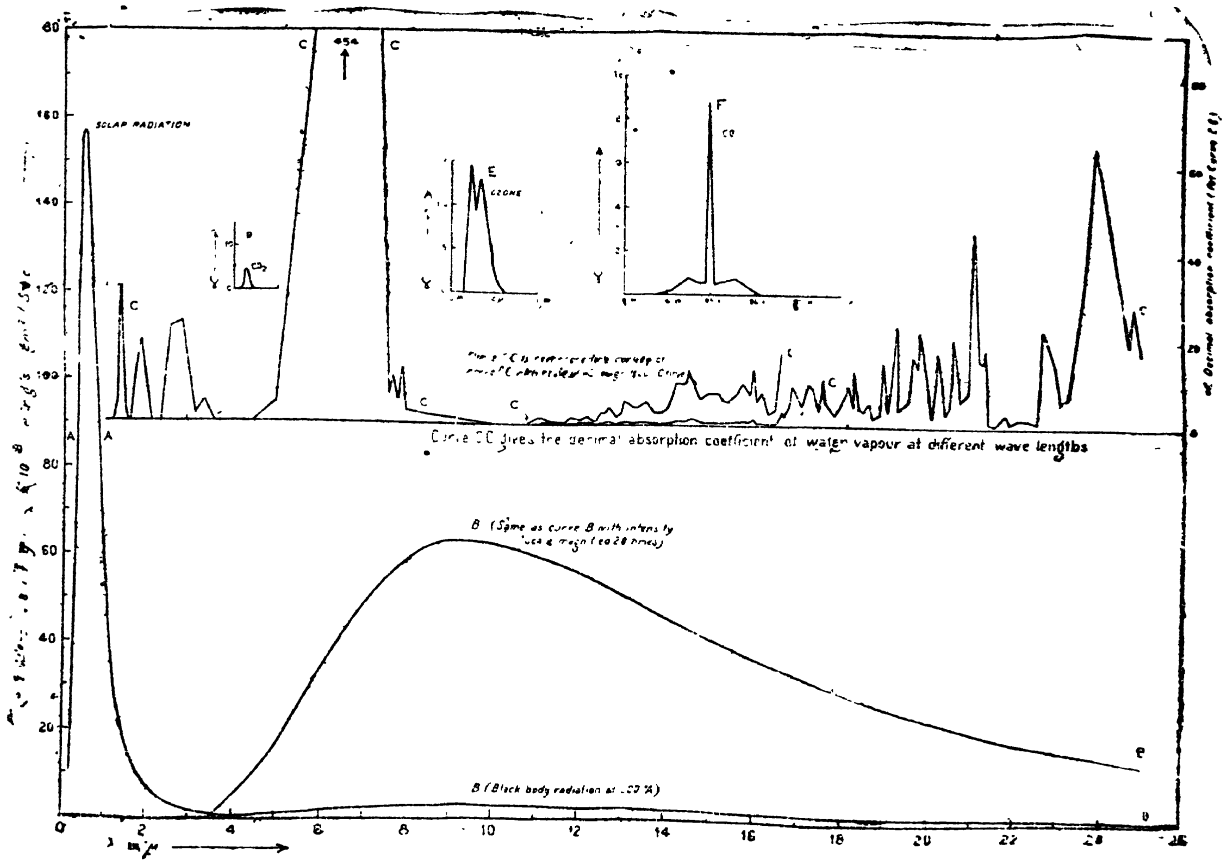


Fig. 2

Solar Radiation, Black body radiation at 300 A and the Decimal Absorption coefficients of ozone, water vapour and carbon-di-oxide.

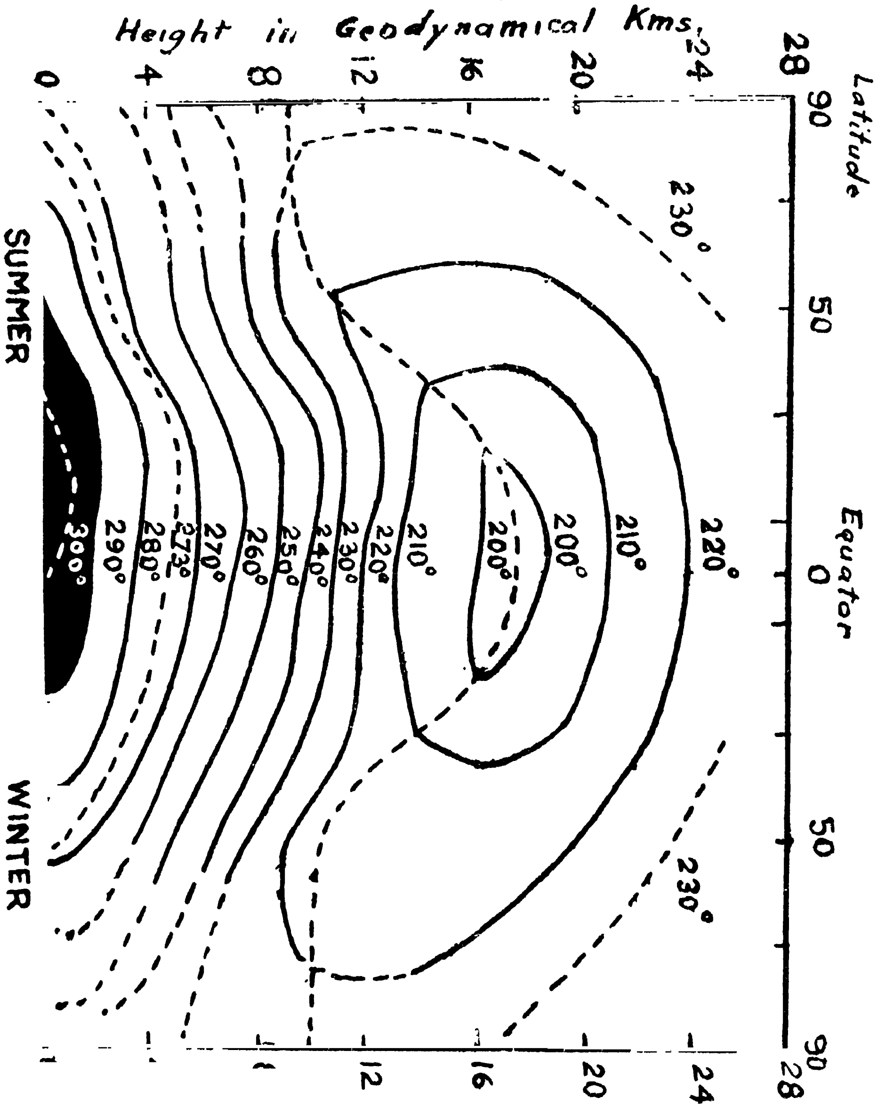


Fig. 3a. Distribution of temperature in the atmosphere (after Ramanathan).

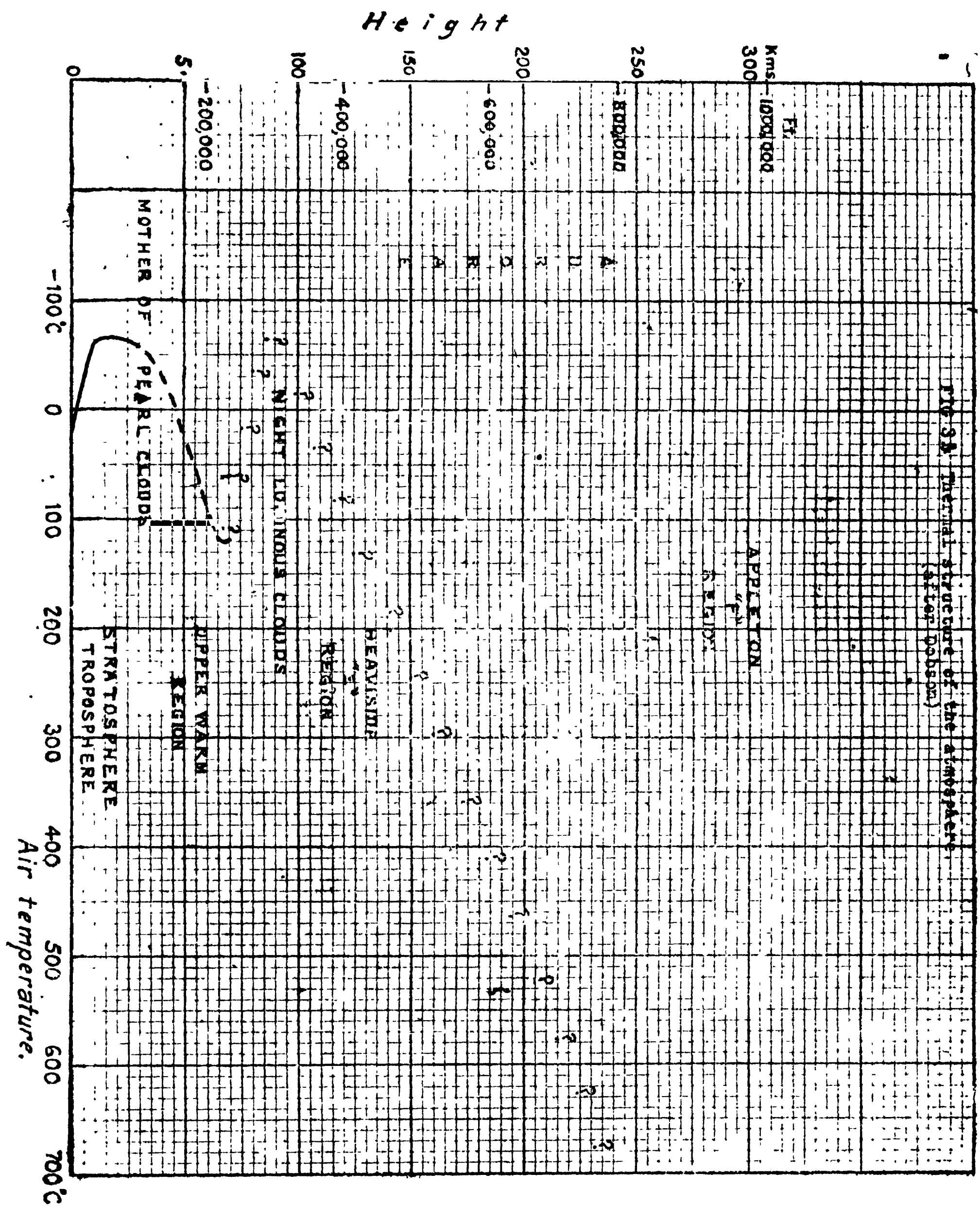


FIG 38 Thermal structure of the atmosphere (after Dobson)

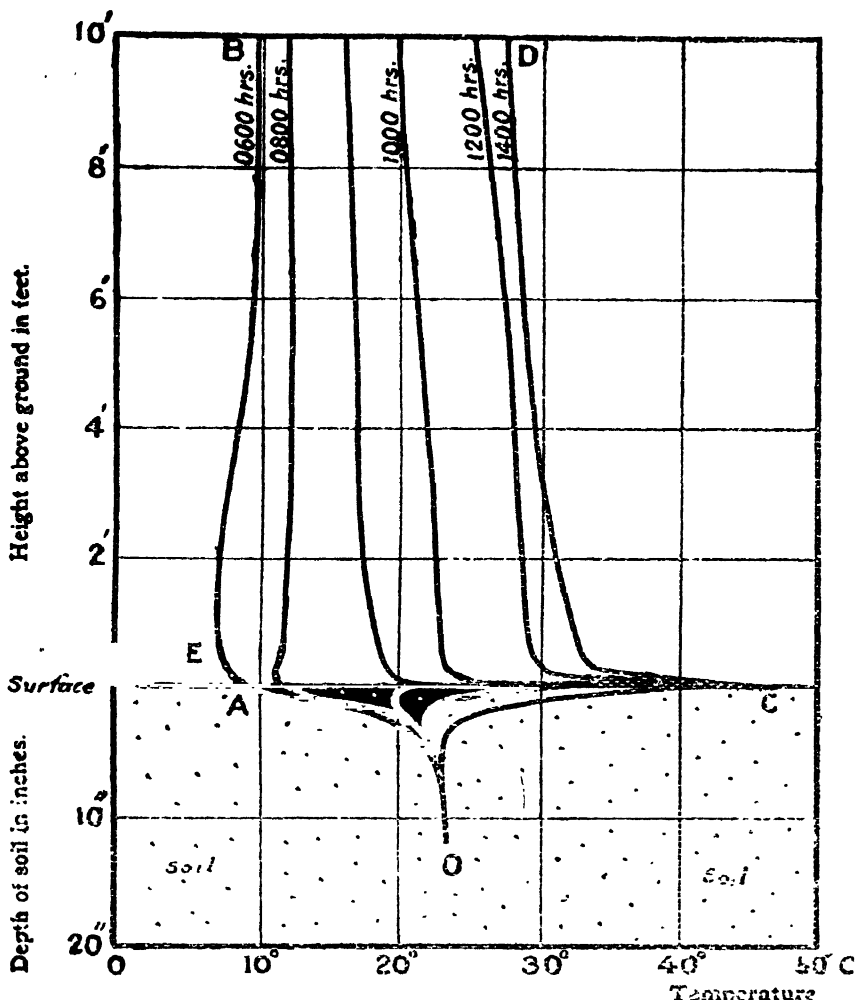


Fig. 4 Diurnal range of temperature in the soil and air layers near the ground surface on 5-1-33.

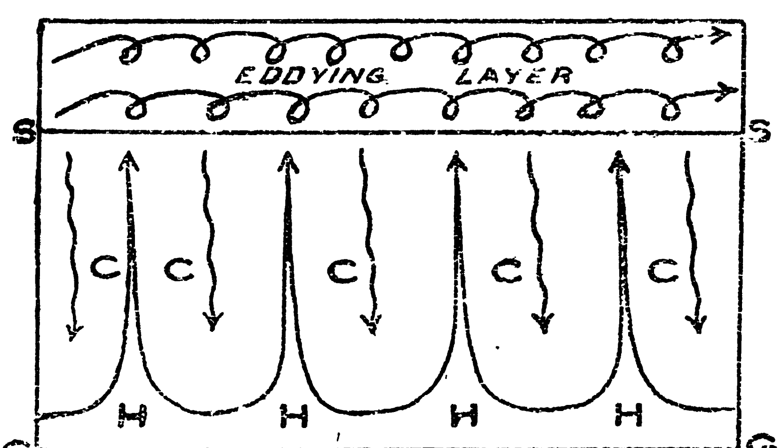


Fig 5 Shimmering layer with rising hot currents H and descending cold currents C.

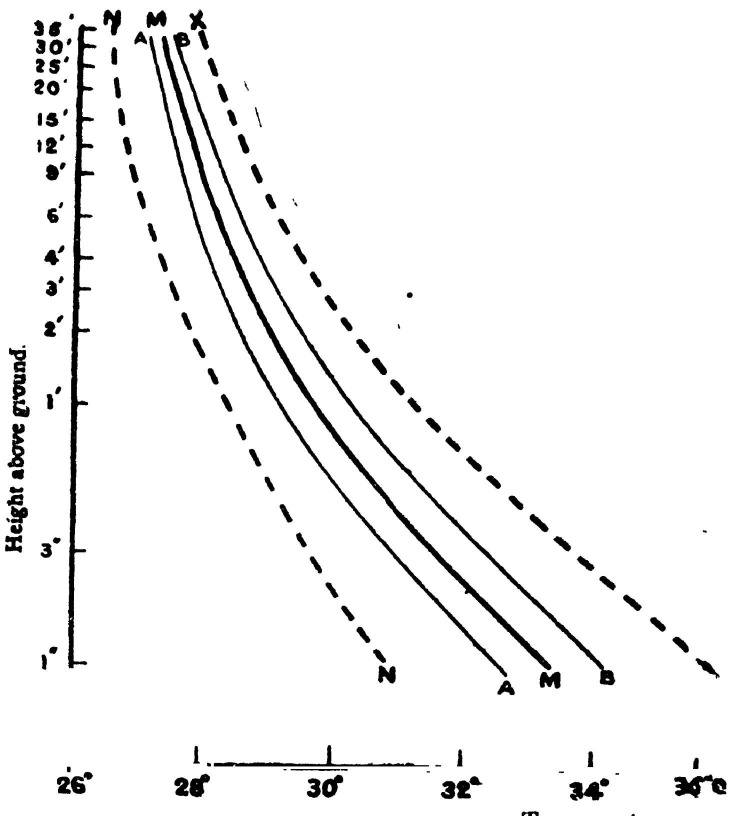


Fig. 6

Fluctuation of air temperature at different levels above ground during the interval 1430—1530 hours., I. S. T. on 6-1-42.

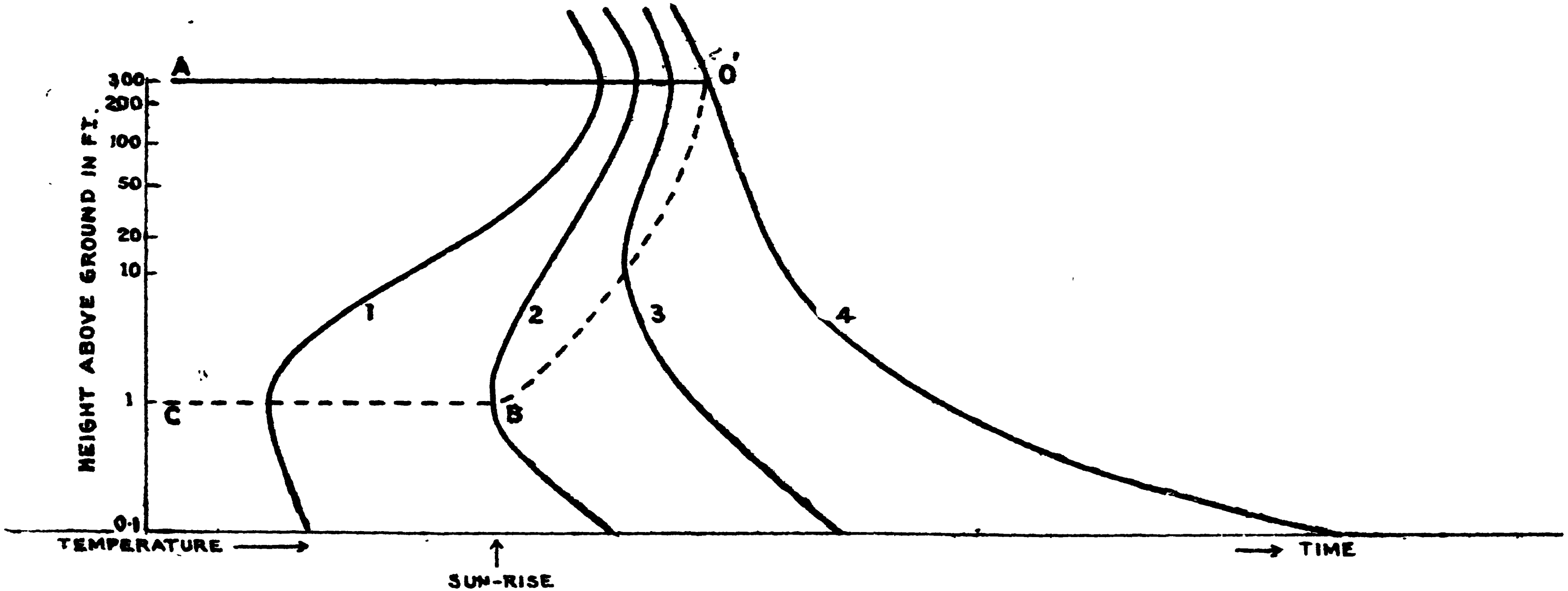


Fig. 10. DESTRUCTION OF INVERSION AFTER SUNRISE

The above is an idealised diagram in which the curves 1 to 4 would correspond roughly to the following hours for a clear winter day at Poona :—

Curve No. :	Approximate time in hours new I. S. T.
1	0700
2	0800
3	0900
4	1000

N.B. :—The temperature scale is as in Fig. 1. BC is about 1 ft. above ground and AO about 300 ft. above ground.

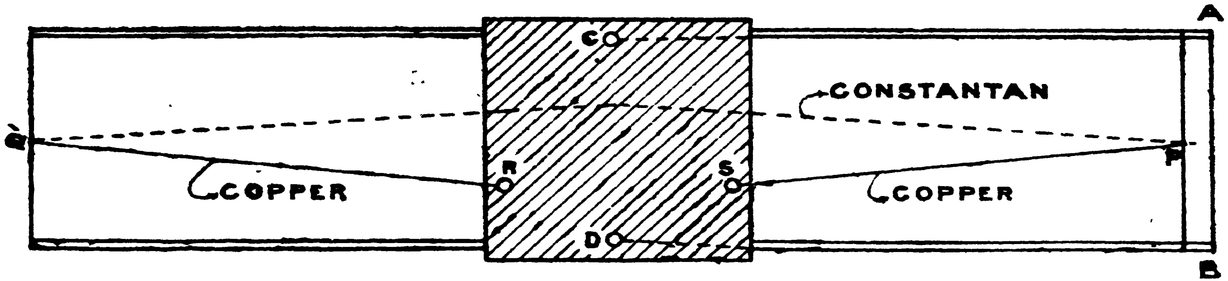


Fig. 11. Apparatus for the measurement of heat loss from the ground surface by convection.

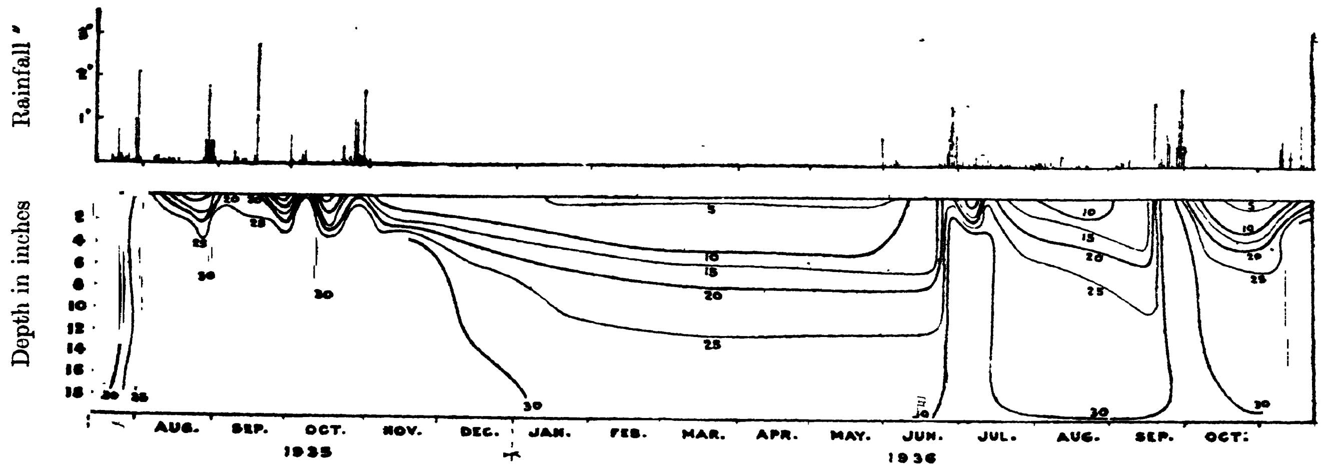


Fig. 12(a). Seasonal variation of moisture % at different depths in the soil ; the rainfall in inches is shown in the upper portion of the figure.

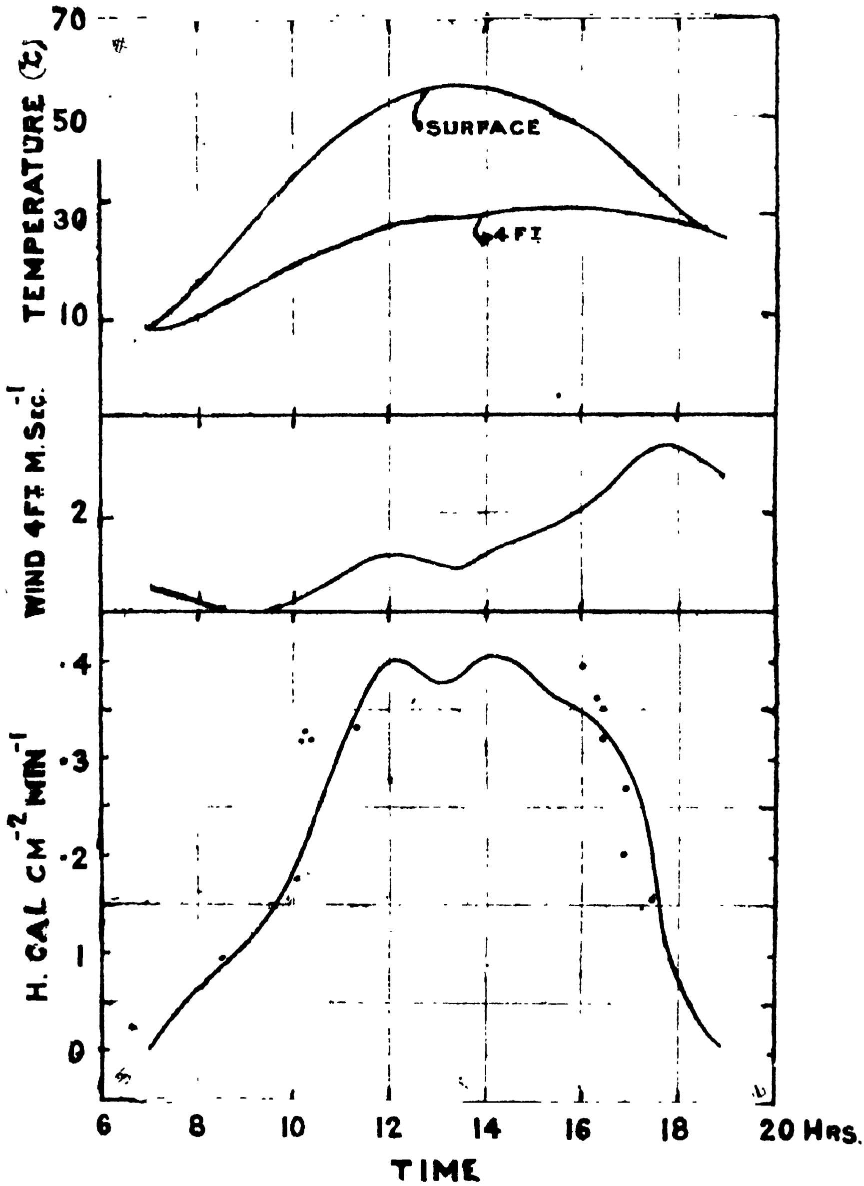


Fig. 12. Curves showing the convective heat loss from the ground, wind velocity at 4ft. and surface temperature and air temperature at 4 ft.

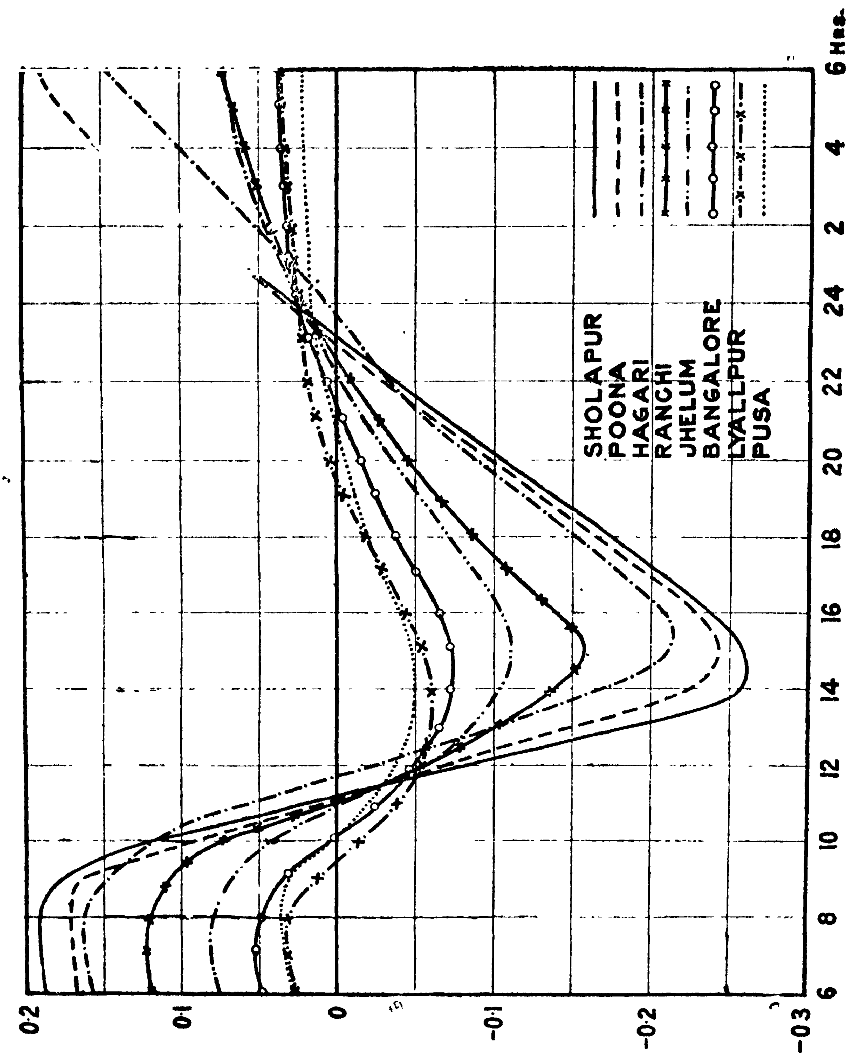


Fig. 13. Diurnal variation in the moisture content of typical soils of India.

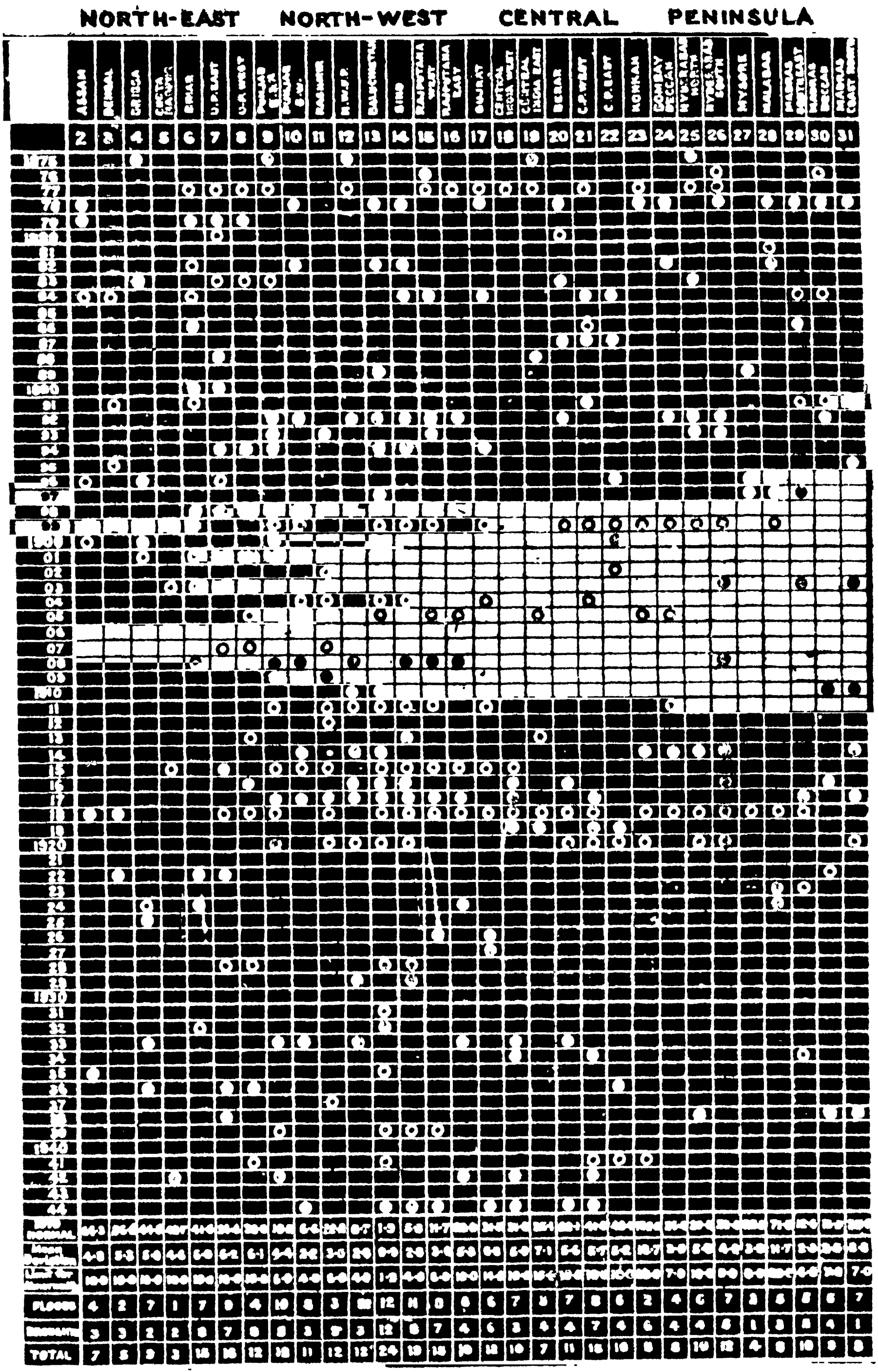


FIG. 16. FLOODS • AND DROUGHTS ○ IN INDIA.

THE FAMINE YEARS OF 1877, 1899 AND 1918 ARE CONSPICUOUS.

Years of floods and droughts have for this purpose been defined as years with anomaly greater than twice the mean deviation.

SECTION OF ANTHROPOLOGY AND ARCHAEOLOGY

PRESIDENT : ANATHNATH CHATTERJI, M.B., B.S.

THE VARIATION IN STATURE AND CEPHALIC INDEX AMONG BENGALEE COLLEGE STUDENTS

(*Delivered on January, 6, 1948*)

GENTLEMEN,

I appreciate very deeply the honour of being asked to deliver the presidential address of the Section of Anthropology and Archaeology of the Thirty fifth Indian Science Congress. I also feel the responsibility of adequately fulfilling a task so well carried out by my predecessors. I must confess that the choosing of a suitable topic, on which I could discourse to this learned assembly, gave me a considerable headache for several days, until, I hit upon the simple plan of selecting a topic not on account of its intrinsic importance but merely because I happen to be interested in it. The theme on which I propose to talk to you to-day is 'The Variation in the Stature and the Cephalic Index among the Bengalee College Students'.

The data presented in the paper are derived from a part of the routine health examination of the students undertaken by the Medical Board attached to the Students' Welfare Committee, Calcutta University, during the years 1922-28. The measurements were taken under my direction and supervision by the late Mr. Harendranath Bose, L.M.S. About 15% of the measurements were checked by me at the examination centre or during a re-call examination instituted to check the correctness of the routine examination. The measurements have been taken according to the rules laid down in the 'Monaco Agreement', the stature, *i.e.*, the standing height vertex, being taken with the shoes off in every case, the subject standing erect, with a Martin's Anthropometer and the maximum head length, glabella to opisthocranion, and the maximum head breadth, euryon to euryon, by means of a Martin's Craniometer, care being taken not to exert undue pressure on the head. The measurements checked by me in no case varied by more than 5 mm. in the case of the stature and 1 mm. in the case of the head length and the head breadth from the recorded measurements. The ages of the students measured varied between 19 and 25, the average for the series being 20·9 years.

For the calculation of the indices and the subsequent statistical treatment I am indebted to the clerical staff attached to the Students' Welfare Office and specially to the Statistical Assistant Mr. Provatchandra Chakraborti, B.Sc.

Originally the data were arranged according to the 28 districts which formed Bengal before the fragmentation of 1947 and in twelve groups, eleven Hindu Castes and Subcastes and Moslems. The simultaneous consideration of the very large number of tables (336) which such an arrangement involved was found to be trying and confusing and after considerable thought and consultations with my learned colleagues Prof. Rajchandra Bose of the Statistical Department, Prof. K. P. Chattopadhyaya and Mr. Tarakchandra Das of the Anthropological Department, Calcutta University, it was finally decided to re-arrange the data into six zones—the five traditional Bengals and Calcutta (Radha, Varendra, Vanga, Chattala and Samatata, *i.e.*, West Bengal, North Central Bengal, East Bengal, South-East Bengal and the Delta)[1] and five groups of people the main Hindu Castes—Brahmins, Vaidyas, Kayasthas and Other Hindus and Moslems. It may not be out of place to point out here that the data reflect the conditions prevalent only among that group of people who are able to bear the expenses of a college education for their sons and wards, *i.e.*, economically speaking the rich and the middle classes, commonly styled as 'Bhadraloks', and do not reflect the condition prevalent among the rest of the population.

In this task of re-grouping a second principle has been introduced, namely, the districts where the averages revealed no significant variation have been grouped together, for instance, the districts of Howrah and Hooghly though outside the Delta or Samatata are included in Samatata, the districts of Faridpur and Backergunge though inside the Delta are included in the zone Vanga and the district of Tipperah in the zone Vanga instead of Chattala. The principle adopted for the comparison between materials from the different districts is as follows :—

" The standard error of a difference $\epsilon(D)$, between two means M_1 and M_2 is obtained by the following formula, in which $\epsilon(M_1)$ is the standard error of the first mean, and $\epsilon(M_2)$ the standard error of the second mean :

$$\epsilon\,(D) = \pm\ \sqrt{\epsilon(M_1)^2 + \epsilon(M_2)^2}$$

The standard error of the difference signifies that there is roughly a two-third probability of a random difference not exceeding the standard error, and practically no probability that it will exceed three times the standard error. If actually we do find a difference larger than three times its standard error, it can be taken that this is not due to chance. If we know that the materials have been chosen in the same manner in all respects except one, it is, then, justifiable to refer the difference in the first place to the circumstances which decided the selection".[2]

---

1. History of Bengal, Vol. I, Chapter XII, p. 377, Dacca University.
2. *Vide*. Statistical Methods for Medical and Biological Students by Gunnar Dahlberg, pp. 96-97.

Zonal Variations

The averages for the Stature and the Cephalic Index together with the Standard Errors of the six zones are shown in Table No. 1 :—

TABLE No. 1

All Zones — Stature and Cephalic Index

Zone	No.	Stature Mean±S.E.	Cephalic Index Mean±S.E.
Radha	1101	166·4± ·1782	79·3± ·1293
Varendra	509	166·1± ·2468	79·3± ·1755
Vanga	2391	165·9± ·1237	79·4± ·0780
Chattala	316	165·1± ·3252	78·4± ·2295
Samatata	3834	166·4± ·0932	81·0± ·0641
Calcutta	1130	167·5± ·1722	81·3± ·1166
Province	9281	166·3± ·0607	80·2± ·0419

An examination of the Table reveals :—

(*a*) That the mean of the Stature is fairly equally distributed over the whole province except Calcutta. The variations between the zones are not significant except in the following cases :—

(1) Samatata and Vanga
(2) Samatata and Chattala
(3) Calcutta and all other zones

(*b*) That in the case of the Cephalic Index there is a wider range in the value of the mean and the variations, where they exist, are markedly significant.

The variations between the following zones are to be noted :—

(1) Radha and Chattala—about 3.5 times the standard error
(2) Samatata and Radha—about 12 times the standard error
(3) Samatata and Varendra—about 9 times the standard error
(4) Samatata and Vanga—about 15 times the standard error
(5) Samatata and Chattala—about 11 times the standard error
(6) Vanga and Chattala—about 4 times the standard error
(7) Varendra and Chattala—more than 3 times the standard error
(8) Calcutta and Radha—about 11.5 times the standard error
(9) Calcutta and Varendra—about 7 times the standard error
(10) Calcutta and Vanga—about 13.5 times the standard error
(11) Calcutta and Chattala—about 11 times the standard error

Therefore there is justification for the division of the whole province into the six zones, Radha, Varendra, Vanga, Chattala, Samatata, and Calcutta as proposed in the paper.

(*c*) At the same time attention must be drawn to the great degree of resemblance between the zones Radha, Varendra and Vanga.

(*d*) Samatata and Calcutta resemble each other closely and together form an area characterised by a tendency to tallness and round-headedness.

For further elucidation of the data I have correlated the Stature and the Cephalic Index in each individual and classified them into nine types or elements :—

short—dolichocephals, mesocephals and brachycephals ;
medium—dolichocephals, mesocephals, and brachycephals ;
tall—dolichocephals, mesocephals, and brachycephals ;

the criterion for sub-division into the different classes being the same as adopted by Haddon and Martin, *viz.*,

Short—below 160 cm.
Medium—from 160 cm. to 169·9 cm.
Tall—170 cm. and above.
Dolichocephals—below 76.0
Mesocephals - 76·0 to 80·9
Brachycephals - 81·0 and above.

The incidence of the different types in the six zones is shown in Table No. 2 :—

TABLE NO. 2

All Zones — Percentage Incidence of Types

Zone	No.	SHORT Doli-cho.	SHORT Meso.	SHORT Bra-chy.	MEDIUM Doli-cho.	MEDIUM Meso.	MEDIUM Bra-chy.	TALL Doli-cho.	TALL Meso.	TALL Bara-chy.
Radha	1101	2·82	6·63	4·90	10·81	28·25	18·71	6·36	12·66	8·90
Varendra	509	3·14	7·47	4·13	11·79	30·84	19·65	4·32	11·00	7·66
Vanga	2391	2·47	8·41	4·89	11·54	27·69	20·32	4·68	12·34	7·65
Chattala	316	4·75	7·91	5·06	19·30	25·32	17·09	6·65	8·54	5·38
Samatata	3739	0·95	5·64	6·30	4·76	27·25	26·99	2·75	13·42	11·93
Calcutta	1130	0·53	3·54	5·31	5·49	21·24	30·44	2·30	15·04	16·11
Province	9226	1·77	6·39	5·48	8·22	26·88	23·95	3·85	12·94	10·51

From an analysis of the above Table the following facts emerge :—

(1) The medium mesocephals are the most numerous type in the population of all the zones except Calcutta where the medium brachycephals predominate.

(2) The medium brachycephals come a close second, together they constitute about half the population, the combined incidence varying from 54% in Samatata to 42% in Chattala (Radha 46.96%—Varendra 50.48%—Vanga 48.10%— Chattala 42.42%— Samatata 54.24%—Calcutta 52.68%).

(3) Next in order are the tall mesocephals in all the zones except Chattala.

(4) The medium dolichocephals are equally important in the zones Radha, Varendra and Vanga, in Chattala they show a marked increase and in Samatata and Calcutta an equally marked decrease in their incidence.

(5) The tall brachycephals and the short mesocephals are just perceptible elements in the composition of the people in all zones except Samatata and Calcutta.

(6) The rest (short dolichocephals, short brachycephals and tall dolichocephals) forms only a small fraction of the population.

(7) In Calcutta and Samatata the dolichocephals, short, medium and tall, are greatly reduced in number as compared with the other zones. They show an increase in the incidence of tall brachycephals.

(8) In Radha, Varendra and Vanga the incidence of the different types is markedly similar.

(9) In Chattala there is a rise in the incidence of short dolichocephals, a marked increase in the number of medium dolichocephals and a fall in the number of tall mesocephals and tall brachycephals.

Group Differences in Different Zones

In the following paragraphs an attempt has been made to assess the value of the variation in the Stature and the Cephalic Index among the different groups in the different zones. The values of the criteria together with the variations of the different groups are given in Tables No. 3 to 14 :—

Zone Radha

TABLE No. 3

Zone Radha — Stature and Cephalic Index

Groups	No.	Stature Mean±S.E.	Cephalic Index Mean±S.E.
Brahmins	379	166·7± ·2997	79·7± ·2095
Vaidyas	45	166·2± ·7556	80·5± ·5548
Kayasthas	230	166·9± ·3958	79·8± ·2466
Other Hindus	328	165·9± ·3335	78·7± ·2032
Moslems	119	166·3± ·5334	78·6± ·3556

An examination of Table No. 3 shows that in zone Radha the variation in the Stature between the groups is not significant. The variation in the Cephalic Index is significant in the following groups : –

(a) Brahmins and Other Hindus (1·0±·292—more than three times its standard error.)
(b) Brahmins and Moslems (1·1±·413—nearly 2·7 times its standard error)
(c) Kayasthas and Other Hindus (1·1±·319—three times its standard error)
(d) Kayasthas and Moslems (1·2±·433—nearly three times its standard error)
(e) Vaidyas and Other Hindus (1·8±·59—over three times its standard error)
(f) Vaidyas and Moslems (1·9±·659—nearly three times its standard error)

To sum up, it appears that there is no significant variation between the groups—Brahmins, Vaidyas and Kayasthas but each of these groups varies significantly from Other Hindus and Moslems. The variation between Other Hindus and Moslems is not significant.

In Table No. 4 the percentage distribution of the different types in the different groups of the zone Radha is given :—

TABLE NO. 4

Zone Radha — Percentage distribution

Groups	No.	SHORT Doli-cho.	SHORT Meso.	SHORT Bra-chy.	MEDIUM Doli-cho.	MEDIUM Meso.	MEDIUM Bra-chy.	TALL Doli-cho.	TALL Meso.	TALL Bra-chy.
Brahmins	379	2·11	5·28	5·02	11·35	25·60	21·38	5·54	12·67	11·09
Vaidyas	45	2·22	4·44	2·22	4·44	28·89	26·66	2·22	8·89	20·00
Kayasthas	230	2·18	6·53	3·48	10·00	27·84	21·31	4·35	15·66	8·70
Other Hindus	328	3·97	8·24	5·49	10·98	32·94	14·64	7·02	10·37	6·40
Moslems	119	3·36	7·56	6·72	12·60	24·36	13·44	12·60	14·28	5·04
Zone	1101	2·82	6·63	4·90	10·81	28·25	18·71	6·36	12·66	8·90

An analysis of the above Table reveals :—

(*a*) That the medium mesocephals form the predominant type in all the groups in the zone Radha. The medium brachycephals come a close second and together they constitute 46·97% of the population.

(*b*) That the medium brachycephals are more numerous among the Brahmins, Vaidyas and Kayasthas than among the Other Hindus and Moslems specially the latter.

(*c*) That the medium dolichocephals are more strongly represented in all the groups in the zone than the tall brachycephals.

Zone Varendra

The relevant figures for zone Varendra are given in Tables No. 5 and 6 :-

TABLE NO. 5

Zone Varendra — Stature and Cephalic Index

Groups	No.	Stature Mean ± S.E.	Cephalic Index Mean ± S.E.
Brahmins	178	166·4 ± ·4400	80·1 ± ·3052
Vaidyas	16	166·0 ± ·9560	78·3 ± 1·1405
Kayasthas	82	166·0 ± ·6275	79·1 ± ·4299
Other Hindus	101	166·5 ± ·5317	79·3 ± ·3737
Moslems	132	166·4 ± ·4646	78·7 ± ·3466

TABLE No. 6

Zone Varendra — Percentage Distribution

Groups	No.	SHORT Doli-cho.	SHORT Meso.	SHORT Bra-chy.	MEDIUM Doli-cho.	MEDIUM Meso.	MEDIUM Bra-chy.	TALL Doli-cho.	TALL Meso.	TALL Bra-chy.
Brahmins	178	3·37	7·87	4·49	7·87	28·09	23·03	2·25	12·92	10·10
Vaidyas	16	0·00	6·25	0·00	25·00	37·50	18·75	6·25	6·25	0·00
Kayasthas	82	3·66	6·10	4·88	10·97	30·49	20·73	4·88	12·19	6·10
Other Hindus	101	0·99	5·94	4·95	13·86	29·70	16·83	5·94	9·90	11·88
Moslems	132	4·54	9·09	3·03	14·39	34·85	16·67	5·30	9·09	3·03
Zone	509	3·14	7·47	4·13	11·79	30·84	19·65	4·32	11·00	7·66

An examination of Table No. 5 shows that the variation in the Stature and the Cephalic Index between the groups in the zone Varendra is not significant except the variation in the Cephalic Index between the Brahmins and Moslems (1·4±·462—more than three times its standard error).
The percentage distribution of types in the different groups in the zone, Table No.6, reveals :—

(*a*) That the medium mesocephals form the predominant type in all the groups in the zone. The medium brachycephals are next in importance and together they constitute 50·48% of the population.

(*b*) That among the Brahmins the medium and tall dolichocephals are less numerous than among the other groups while the medium and tall brachycephals are more numerous.

(*c*) The group Other Hindus shows a low incidence of short dolichocephals accompanied by a rise in the incidence of tall brachycephals.

(*d*) The group Moslems differs from the Brahmins of the zone in having a larger number of medium dolichocephals and a smaller number of tall brachycephals.

To sum up, the main feature of the distribution of types in the groups in the zone Varendra is the predominance of the medium mesocephals and brachycephals in all the groups in the zone.

Zone Vanga

The variation in the Stature and the Cephalic Index in the groups of the zone Vanga is given in Table No. 7 and the percentage incidence of types in Table No. 8 :—

TABLE No. 7

Zone Vanga — Stature and Cephalic Index

Groups	No.	Stature Mean±S.E.	Cephalic Index Mean±S.E.
Brahmins	650	165·90± ·2322	79·48± ·1504
Vaidyas	395	168·00± ·3121	79·21± ·1836
Kayasthas	659	165·51± ·2312	79·32± ·1443
Other Hindus	466	165·00± ·2867	79·26± ·1847
Moslems	221	165·14± ·4012	79·87± ·2596

TABLE No. 8

Zone Vanga | Percentage Distribution

Groups	No.	SHORT Dolicho.	SHORT Meso.	SHORT Brachy.	MEDIUM Dolicho.	MEDIUM Meso.	MEDIUM Brachy.	TALL Dolicho.	TALL Meso.	TALL Brachy.
Brahmins	650	2·46	7·39	3·69	11·54	28·15	21·69	5·54	9·69	9·85
Vaidyas	395	2·28	5·06	3·54	11·90	24·81	16·45	6·58	18·48	10·89
Kayasthas	659	2·73	9·56	4·55	11·23	29·74	20·48	3·19	12·75	5·77
Other Hindus	466	3·00	9·66	6·22	12·87	27·47	20·82	4·72	9·87	5·36
Moslems	221	0·90	11·31	9·05	9·05	25·79	21·72	3·17	13·12	5·88
Zone	2391	2·47	8·11	4·89	11·54	27·69	20·32	4·68	12·34	7·65

An analysis of the Tables No. 7 and 8 brings out :—

(*a*) That the variation in the Stature and the Cephalic Index in the groups of the zone Vanga is not significant except in the case of the Vaidyas who are taller than the members of the other groups.

(*b*) That the medium mesocephals are the predominant type in all the groups of the zone Vanga and together with the medium brachycephals constitute 48.1%of the population.

(*c*) The Brahmins and Vaidyas show a greater incidence of tall brachycephals than the other groups.

(*d*) The Kayasthas show a close resemblance to the group Other Hindus.

(*e*) The Other Hindus and Moslems reveal a greater incidence of short brachycephals with a corresponding decrease in tall brachycephals when compared with the Brahmins and Vaidyas of the zone.

Zone Chattala

Tables No. 9 and 10 show the variation of the criteria and the percentage distribution in the different groups of the zone Chattala :—

TABLE No. 9

Zone Chattala | Stature and Cephalic Index

Groups	No.	Stature Mean±S.E.	Cephalic Index Mean±S.E.
Brahmins	37	164·6± ·7496	77·7± ·6324
Vaidyas	24	164·1± ·8600	77·2± ·6846
Kayasthas	112	165·1± ·5896	77·2± ·3515
Other Hindus	67	165·0± ·7892	79·7± ·5228
Moslems	76	165·4± ·6217	79·7± ·4669

TABLE NO. 10

Zone Chattala — Percentage Distribution

Groups	No.	SHORT Dolicho.	SHORT Meso.	SHORT Brachy.	MEDIUM Dolicho.	MEDIUM Meso.	MEDIUM Brachy.	TALL Dolicho.	TALL Meso.	TALL Brachy.
Brahmins	37	5·41	8·10	0·00	24·32	29·73	21·62	5·41	5·41	0·00
Vaidyas	24	0·00	8·33	0·00	37·50	29·17	16·66	4·17	4·17	0·00
Kayasthas	112	7·14	8·04	2·68	23·21	27·68	8·93	8·04	8·04	6·25
Other Hindus	67	4·48	7·46	8·95	14·92	19·40	19·40	4·48	11·91	8·95
Moslems	76	2·63	7·89	9·21	9·21	23·08	25·00	7·89	9·21	5·26
Zone	316	4·75	7·91	5·06	19·30	25·32	17·09	6·65	8·54	5·38

An analysis of Table No. 9 shows :-

(*a*) That the variation in the Stature between the different groups is not significant.

(*b*) The variation in the Cephalic Index is significant in the following cases :—

(*i*) Brahmins and Other Hindus (2.0 ± ·259—7 times its standard error)
(*ii*) Brahmins and Moslems (2.0 ± ·248—8 times its standard error)
(*iii*) Kayasthas and Other Hindus (2.5 ± ·630—4 times its standard error)
(*iv*) Kayasthas and Moslems (2.5 ± ·584—over 4 times its standard error)
(*v*) Vaidyas and Other Hindus (2.5 ± ·861—3 times its standard error)
(*vi*) Vaidyas and Moslems (2.5 ± ·829—3 times its standard error).

It is difficult to generalise on the incidence of the types in the groups in this zone owing to the small size of the samples (*vide* Table No. 10). It would, however, appear that the medium mesocephals still form the predominant type and together with the medium brachycephals constitute 42.41% of the population. The incidence of the medium and the short dolichocephals among the Brahmins and Kayasthas of the zone is higher than among the corresponding groups in other zones. On the other hand the short and tall brachycephals among the Brahmins and Kayasthas of the zone show a decrease in their incidence.

Zone Samatata

The intergroup variations in the Stature and the Cephalic Index and the percentage distribution of types for the zone Samatata are given in Tables No. 11 and 12 :—

TABLE NO. 11

Zone Samatata — Stature and Cephalic Index

Groups	No.	Stature Mean ± S.E.	Cephalic Index Mean ± S.E.
Brahmins	1515	167·4 ± ·1470	81·3 ± ·1002
Vaidyas	193	166·3 ± ·4312	80·2 ± ·3052
Kayasthas	1026	166·4 ± ·1748	81·1 ± ·1227
Other Hindus	792	165·3 ± ·2017	80·3 ± ·1427
Moslems	308	164·8 ± ·3298	80·3 ± ·2187

TABLE No. 12

Zone Sāmatata — Percentage Distribution

Groups	No.	SHORT Doli-cho.	SHORT Meso.	SHORT Bra-chy.	MEDIUM Doli-cho.	MEDIUM Meso.	MEDIUM Bra-chy.	TALL Doli-cho.	TALL Meso.	TALL Bra-chy
Brahmins	1188	0·60	3·16	5·85	4·50	25·27	28·49	2·22	15·32	14·58
Vaidyas	162	0·62	8·64	6·79	10·49	21·61	22·22	4·94	14·81	9·88
Kayasthas	1026	1·07	5·46	5·65	3·90	26·32	30·02	2·44	13·35	11·79
Other Hindus	795	1·38	8·30	7·17	4·91	32·96	21·64	2·89	11·82	8·93
Moslems	308	1·30	9·74	8·12	5·52	28·25	25·97	4·87	7·79	8·44
Zone	3779	0·97	5·64	6·30	4·76	27·25	26·99	2·75	13·42	11·93

An analysis of Table No. 11 shows :

(*a*) That the variation in the Stature between the Brahmins and all the other groups is significant :

(*i*) Brahmins and Kayasthas—(1.0 ± .23 —over 4 times its S.E.)
(*ii*) Brahmins and Other Hindus—(2.1 ± .25—about 8 times its S.E.)
(*iii*) Brahmins and Moslems—(2.6 ± .36—over 7 times its S.E.)
(*iv*) Brahmins and Vaidyas—(1.1 ± .45—about 2.5 times its S.E.)

(*b*) That the variation in the Stature between the Kayasthas on the one hand and the Other Hindus and Moslems on the other is significant :—

(*i*) Kayasthas and Other Hindus—(1.1 ± .27—over 4 times its S. E.)
(*ii*) Kayasthas and Moslems—(1.6 ± .37—over 4 times its S. E.)

(*c*) That the variation in the Cephalic Index between the Brahmins and Kayasthas is not significant.

(*d*) The variation in the Cephalic Index between the Brahmins on one hand and the Vaidyas, Other Hindus and Moslems on the other is significant :—

(*i*) Brahmins and Vaidyas—(1.1 ± .32—over 3 times its S. E.)
(*ii*) Brahmins and Other Hindus—(1.0 ± .17—nearly 6 times its S. E.)
(*iii*) Brahmins and Moslems—(0.7 ± .24—about 3 times its S. E.)

(*e*) That the variation in the Cephalic Index between the Kayasthas and Other Hindus is significant :—

Kayasthas and Other Hindus—(0.8 ± .19—over 4 times its S. E.)

(*f*) That the variation in the Cephalic Index between the Kayasthas and Moslems is not significant.

(*g*) That the variation in the Stature and the Cephalic Index between the Kayasthas and Vaidyas is not significant.

(*h*) That the variation in the Stature and the Cephalic Index between the Other Hindus and Moslems is not significant.

An analysis of the Table of the percentage incidence of types, Table No. 12, reveals :—

(*a*) That the medium mesocephals and the medium brachycephals are equally important in the population of the zone, together they constitute 54.24% of the population ; but the brachycephals are more numerous among

the Brahmins and Kayasthas while the medium mesocephals are more strongly represented among the Other Hindus and Moslems.

(*b*) That the tall brachycephals are more numerous in all the groups than in other zones and are strongly represented among the Brahmins and Kayasthas.

(*c*) The dolichocephals short, medium and tall show a marked decrease in their incidence in all the groups in the zone.

Zone Calcutta

The relevant figures for zone Calcutta are given in Tables Nos. 13 and 14 :—

TABLE No. 13

Zone Calcutta — Stature and Cephalic In

Groups	No.	Stature Mean ± S.E.	Cephalic Index Mean ± S.E.
Brahmins	266	167·95 ± ·3525	81·0 ± ·2367
Vaidyas	43	169·17 ± ·8357	80·9 ± ·4575
Kayasthas	395	167·65 ± ·2958	81·4 ± ·1927
Other Hindus	354	167·47 ± ·3029	81·6 ± ·2195
Moslems	72	166·01 ± ·7012	80·0 ± ·4360

The variations in the Stature and the Cephalic Index between the groups excepting the Moslems are not significant. In zone Calcutta it is desirable to leave out the Moslems from our consideration as a large proportion of the small sample studied is composed of Non-Bengalee Moslems.

TABLE No. 14

Zone Calcutta — Percentage Distribution

Groups	No.	SHORT Doli-cho.	SHORT Meso.	SHORT Bra-chy.	MEDIUM Doli-cho.	MEDIUM Meso.	MEDIUM Bra-chy.	TALL Doli-cho.	TALL Meso.	TALL Bra-chy.
Brahmins	266	0·38	3·38	5·64	6·01	20·68	24·43	1·88	19·92	17·67
Vaidyas	43	0·00	0·00	4·65	4·65	18·60	30·23	2·33	23·26	16·28
Kayasthas	395	0·76	3·54	5·32	5·06	17·97	34·68	2·78	12·66	17·21
Other Hindus	354	0·28	2·82	5·65	5·68	24·01	31·64	1·69	12·99	15·82
Moslems	72	1·39	9·72	2·78	8·33	29·17	23·61	4·17	15·28	5·55
Zone	1130	0·53	3·54	5·31	5·49	21·24	30·44	2·30	15·04	16·11

An analysis of the percentage distribution, Table No. 14, brings out the following features :—

(*a*) The medium brachycephals form the most numerous element in the population. The medium mesocephals are next in order of importance and together they constitute 51.68 % of the population.

(*b*) The tall brachycephals show a marked rise in their incidence in all the groups.

(c) The dolichocephals short, medium and tall show a very low incidence.

To sum up, the consideration of the inter-group variations in the various zones brings out the following main facts :—

(A) The variation in the Stature in different groups in the zones is not significant except in the following cases :—

(i) In zones Varendra and Calcutta the Vaidyas are taller than all the other groups.

(ii) In Samatata the Brahmins are slightly taller than all the other groups.

(B) The Cephalic Index is a more variable criterion and the following main findings deserve consideration :—

(i) Variations in the Cephalic Index between the Brahmins, Vaidyas and Kayasthas are not significant except in zone Samatata where the variations between the Vaidyas and Brahmins, and the Vaidyas and Kayasthas are significant.

(ii) Variation in the Cephalic Index between the Brahmins, Vaidyas and Kayasthas on the one hand and the Other Hindus on the other is significant only in Radha and Calcutta and between the Brahmins and Other Hindus in Samatata.

(iii) Variation in the Cephalic Index between the Moslems and Brahmins is significant in all the zones except Vanga and between the Moslems on the one hand and the Kayasthas and Vaidyas on the other in Radha and Chattala. The variation in the Cephalic Index between the Moslems and Other Hindus is not significant in any zone.

(iv) The medium mesocephals and brachycephals together form the most numerous type in the composition of the different groups in all the zones.

(v) The tall brachycephals are more frequent among the Brahmins and Kayasthas in all the zones except Chattala.

Zonal Fluctuations in the Same Group

In the following paragraphs an attempt has been made to assess the fluctuations in the same group in the different zones. The averages for the Stature and the Cephalic Index together with their variations for the group Brahmins is given in Table No. 15 :—

TABLE No. 15

Group Brahmins — Stature and Cephalic Index

Zone	No.	Stature Mean ± S.E.	Cephalic Index Mean ± S.E.
Varendra	178	166·4 ± ·400	80·1 ± ·3052
Radha	379	166·7 ± ·2997	79·7 ± ·2095
Samatata	1515	167·4 ± ·1470	81·3 ± ·1002
Vanga	650	165·9 ± ·2322	79·6 ± ·1504
Chattala	37	164·6 ± ·7496	77·7 ± ·6324
Calcutta	266	167·9 ± ·3525	81·0 ± ·2367

An analysis of the Table reveals :—

(*a*) That the variation both in the Stature and the Cephalic Index is significant in the following cases :—

(*i*) Samatata and Vanga
(*ii*) Samatata and Chattala
(*iii*) Calcutta and Vanga
(*iv*) Calcutta and Chattala

(*b*) That the variation in the Cephalic Index only is singificant in the following cases :—

(*i*) Samatata and Radha
(*ii*) Samatata and Varendra
(*iii*) Calcutta and Radha
(*iv*) Varendra and Chattala
(*v*) Radha and Chattala

The percentage distribution of the types is given in Table No. 16.

TABLE No. 16

Group Brahmins — Percentage Distribution

Zone	No.	SHORT Doli-cho.	SHORT Meso.	SHORT Bra-chy.	MEDIUM Doli-cho.	MEDIUM Meso.	MEDIUM Bra-chy.	TALL Doli-cho.	TALL Meso.	TALL Bra-chy.
Varendra	178	3·37	7·87	4·49	7·87	28·09	23·03	2·25	12·92	10·11
Radha	379	2·11	5·28	5·02	11·35	25·60	21·38	5·54	12·67	11·09
Samatata	1488	0·60	3·16	5·85	4·50	25·27	28·49	2·22	15·32	14·58
Vanga	650	2·46	7·39	3·69	11·54	28·15	21·69	5·54	9·69	9·85
Chattala	37	5·41	8·10	0·00	24·32	29·73	21·62	5·41	5·41	0·00
Calcutta	266	0·38	3·38	5·64	6·01	20·68	24·13	1·88	19·92	17·67

Leaving out of consideration the Brahmins from Chattala on account of the smallness of the sample an analysis of the Table reveals :—

(*a*) That the medium mesocephals and medium brachycephals form the most numerous types in the composition of the Brahmins, the medium brachycephals predominating in Samatata and Calcutta. Together they constitute the predominant type in all the zones.

(*b*) That the tall brachycephals are more numerous in Samatata and Calcutta. They constitute about 10% of the Brahmins in the zones Radha, Vanga and Varendra and about 15% in Samatata and Calcutta.

(*c*) That the medium dolichocephals reach this level of over 10% of the Brahmins in Radha and Vanga.

Vaidyas

The variation in the Stature and the Cephalic Index for the group Vaidyas and the percentage distribution of the types are given in Tables Nos. 17 and 18 :—

TABLE No. 17

Group Vaidyas — Stature and Cephalic Inde

Zone	No.	Stature Mean ± S.E.	Cephalic Index Mean ± S.E.
Varendra	16	166·0 ± ·9560	78·3 ± 1·1405
Radha	45	166·2 ± ·7556	80·5 ± ·5548
Samatata	193	166·3 ± ·4312	80·2 ± ·3052
Vanga	395	168·0 ± ·3121	79·2 ± ·1836
Chattala	24	164·1 ± ·8600	77·2 ± ·6846
Calcutta	13	169·2 ± ·8357	80·9 ± ·4575

TABLE No. 18

Group Vaidyas — Percentage Distribution

Zone.	No.	SHORT Doli-cho.	SHORT Meso.	SHORT Bra-chy.	MEDIUM Doli-cho.	MEDIUM Meso.	MEDIUM Bra-chy.	TALL Doli-cho.	TALL Meso.	TALL Bra-chy.
Varendra	16	3·66	6·10	4·88	10·97	30·49	20·73	4·88	12·19	6·10
Radha	45	2·22	6·44	2·22	4·44	28·89	26·66	2·22	8·89	20·00
Samatata	162	0·62	8·64	6·79	10·49	21·61	22·22	4·94	14·81	0·88
Vanga	395	2·28	5·06	3·54	11·90	24·81	16·45	6·58	18·48	10·89
Chattala	24	0·00	8·33	0·00	37·50	29·17	16·66	4·17	4·17	0·00
Calcutta	43	0·00	0·00	4·65	4·65	18·60	32·23	2·23	23·26	16·28

On account of the smallness of the samples in the different zones except Samatata and Vanga a generalisation cannot be made about the inter-zonal fluctuations. It appears, however, that the variation in the Stature and the Cephalic Index is significant between the Vaidyas of Vanga and Samatata, *i.e.*, the Vaidyas of Samatata are shorter and more round-headed than the Vaidyas of Vanga. The percentage incidence of the types shows that the medium mesocephals and the medium brachycephals together form the predominant type, the brachycephals being more numerous in Samatata and the mesocephals in Vanga.

Kayasthas

The relevant figures for the group Kayasthas are given in Tables Nos. 19 and 20 :—

TABLE No. 19

Group Kayasthas — Stature and Cephalic Index

Zone	No.	Stature Mean ± S.E.	Cephalic Index Mean ± S.E.
Varendra	82	166·0 ± ·6275	79·1 ± ·4299
Radha	230	166·9 ± ·3958	79·8 ± ·2466
Samatata	1026	166·4 ± ·1748	81·1 ± ·1227
Vanga	659	165·5 ± ·2312	79·3 ± ·1443
Chattala	112	165·1 ± ·5896	77·2 ± ·3515
Calcutta	395	167·6 ± ·2958	81·4 ± ·1927

An analysis of Table No. 19 shows :—

(*a*) That the variation in the Stature and the Cephalic Index is significant in the following cases :—

(*i*) Samatata and Vanga
(*ii*) Calcutta and Vanga
(*iii*) Calcutta and Chattala

(*b*) That the variation in the Cephalic Index only is significant between :

(*i*) Radha and Samatata
(*ii*) Radha and Vanga
(*iii*) Radha and Chattala
(*iv*) Radha and Calcutta
(*v*) Varendra and Samatata
(*vi*) Varendra and Chattala
(*vii*) Varendra and Calcutta
(*viii*) Vanga and Chattala
(*ix*) Samatata and Vanga
(*x*) Samatata and Chattala

(*c*) That the variation in the Stature only is significant in the following cases :—

(*i*) Samatata and Calcutta
(*ii*) Radha and Vanga.

To sum up it would appear that there is considerable variation in the Cephalic Index among the Kayasthas of the different zones,

TABLE No. 20

Group Kayasthas Percentage Distribution

Zone	No.	SHORT Dolicho.	SHORT Meso.	SHORT Brachy.	MEDIUM Dolicho.	MEDIUM Meso.	MEDIUM Brachy.	TALL Dolicho.	TALL Meso.	TALL Brachy.
Varendra	82	3·66	6·10	1·88	10·97	30·49	20·73	4·88	12·19	6·10
Radha	230	2·18	6·53	3·48	10·00	27·84	21·31	4·35	15·66	8·70
Samatata	1026	1·07	5·46	5·65	3·90	26·32	30·02	2·44	13·35	11·79
Vanga	659	2·73	9·56	4·55	11·23	29·74	20·18	3·19	12·75	5·77
Chattala	112	7·14	8·04	2·68	23·21	27·68	8·93	8·04	8·04	6·25
Calcutta	395	0·76	3·54	5·30	5·06	17·97	34·68	2·78	12·66	17·21

An analysis of the percentage distribution of the types discloses :—

(*a*) The medium mesocephals are more numerous than the medium brachycephals in all the zones except Samatata and Calcutta, together they form the predominant type in all the areas.

(*b*) The tall brachycephals do not contribute markedly to the composition of the Kayasthas except in Samatata and Calcutta. In Chattala there is a sharp drop in the incidence of medium brachycephals with a corresponding rise in the medium dolichocephals. In fact the dolichocephals among the Kayasthas in Chattala show a marked increase.

Other Hindus

The corresponding figures for the Other Hindus are given in Tables Nos. 21 and 22.

TABLE No. 21

Group Other Hindus Stature and Cephalic Index

Zone	No.	Stature Mean ± S.E.	Cephlic Index Mean ± S.E.
Varendra	101	166·5 ± ·5317	79·3 ± ·3737
Radha	328	165·9 ± ·3335	78·7 ± ·2032
Samatata	795	165·3 ± ·2017	80·3 ± ·1427
Vanga	446	165·0 ± ·2867	79·3 ± ·1847
Chattala	67	165·0 ± ·7892	79·7 ± ·5228
Calcutta	354	167·5 ± ·3029	81·6 ± ·2195

Table No. 21 shows that the variation between the different zones is not significant excepting the variation in the Cephalic Index between Samatata and Radha and Samatata and Vanga. In other words the Other Hindus exhibit a remarkable degree of similarity all over the province.

TABLE No. 22

Group Other Hindus Percentage Distribution

		SHORT			MEDIUM			TALL		
Zone	No.	Doli-cho.	Meso.	Bra-chy.	Doli-cho.	Meso.	Bra-chy.	Doli-cho.	Meso.	Bra-chy.
Varendra	101	0·99	5·94	4·95	13·86	29·70	16·83	5·94	9·90	11·88
Radha	328	3·97	8·24	5·49	10·98	32·94	14·64	7·02	10·37	6·40
Samatata	795	1·38	8·30	7·17	4·91	32·96	21·64	2·89	11·82	8·93
Vanga	446	3·00	9·66	6·22	12·87	27·47	20·82	4·72	9·87	5·36
Chattala	67	4·48	7·16	8·95	14·92	19·40	19·40	4·48	11·94	8·95
Calcutta	354	0·28	2·82	5·65	5·08	24·91	31·64	1·69	12·99	15·82

The main features as revealed by an analysis of the percentage incidence of the types, Table No. 22, are :—

(*a*) A predominance of the medium mesocephals in all the zones except Chattala where the medium brachycephals are equally important and in Calcutta where the medium brachycephals are more numerous.

(*b*) A perceptible incidence of tall brachycephals in Calcutta and Varendra.

(*c*) The comparative rarity of dolichocephals in Samatata and Calcutta.

Moslems

The fluctuations for the group Moslems are shown in Tables Nos 23 and 24 :—

TABLE No 23

Group Moslems Stature and Cephalic Index

Zone	No.	Stature Mean ± S.E.	Cephalic Index Mean ± S.E.
Varendra	132	166·4 ± ·4646	78·7 ± ·3466
Radha	119	166·3 ± ·5334	78·6 ± ·3556
Samatata	308	164·8 ± ·3298	80·6 ± ·2187
Vanga	221	163·1 ± ·4012	79·9 ± ·2596
Chattala	76	165·4 ± ·6217	79·7 ± ·4669
Calcutta	72	166·0 ± ·7012	80·0 ± ·4360

An analysis of Table No. 23 shows :—

(*a*) That the Stature seems to be more variable among the Moslems. The variations between the following zones are significant—Samatata and Vanga, Radha and Vanga, Varendra and Vanga, and Vanga and Chattala.

(*b*) That the variations in the Cephalic Index are significant between Samatata and Radha, Samatata and Varendra, and Radha and Vanga.

TABLE No. 24

Group Moslems — Percentage Distribution

Zone	No.	SHORT Dolicho.	SHORT Meso.	SHORT Brachy.	MEDIUM Dolicho.	MEDIUM Meso.	MEDIUM Brachy.	TALL Dolicho.	TALL Meso.	TALL Brachy.
Varendra	132	4·54	9·09	3·03	14·39	34·85	16·67	5·30	9·09	3·03
Radha	119	3 36	7 56	6·72	12 60	24·36	13·44	12·60	14·28	5·04
Samatata	308	1·30	9·74	8·42	5·52	28·25	25·97	4·87	7·79	8·44
Vanga	221	0·90	11·31	9·05	9·05	25·79	21·72	3·17	13·12	5·88
Chattala	76	2·63	7·89	9·21	9·21	23·68	25·00	7·89	9·21	5·26
Calcutta	72	1·39	9·72	2·78	8·33	29·17	23·61	4·17	15·28	5 55

An analysis of the percentage incidence brings out the following facts :—

(*a*) The medium mesocephals are the most numerous group except in Chattala where the medium brachycephals are present in greater numbers.

(*b*) The tall brachycephals show a marked fall in their incidence in all the zones as compared with other groups.

Here grave doubts and despondence overwhelm the investigator. He realises that the criteria with which he has been assessing the inter-group variations are not unfailing guides. It appears that zonal conditions play a considerable part in the origin of fluctuations. They are not only affected by zonal conditions but by their very nature have co-efficients of variability which are not negligible—in the series under consideration the co-efficients of variability are found to be 3.5 for the Stature and 5.0 for the Cephalic Index —and in the interpretation of the findings due allowances will have to be made for these fluctuations. Like all laboratory diagnoses of biological phenomena these findings should be taken with a grain of salt, minor variations neglected and only the major ones stressed. This brings the design of the survey into prominence and not the method used for analysis. For further work the zones should be split up into smaller units with known environmental conditions to enable the future worker to assess the effects with greater accuracy.

The next step should be an attempt to assess in measureable terms the respective parts played by group variations and zonal fluctuations in determining the Stature and in moulding the head shape in the groups under consideration. For illustrating the problem let us compare the figures of variations for the groups—Brahmins of Samatata and Other Hindus of Samatata and Brahmins of Vanga (Table No. 25).

TABLE No. 25

	Variation—Stature	Variation—Cephalic Index
Brahmins of Samatata and Other Hindus of Samatata	2·1 ± ·250	1·0 ± ·174
Brahmins of Samatata and Brahmins of Vanga	1·5 ± ·275	1·82 ± ·181
Brahmins of Vanga and Other Hindus of Samatata	0·6 ± ·307	0·82 ± ·205

An examination of the Table shows that :—

(*a*) The variation in the Stature between the Brahmins of Samatata and the Other Hindus of Samatata is greater than the variation between the Brahmins of Samatata and the Brahmins of Vanga.

(*b*) The variation in the Stature between the Brahmins of Vanga and the Other Hindus of Samatata is small and not significant.

(*c*) The variation in the Cephalic Index between the Brahmins of Samatata and the Brahmins of Vanga is greater than the variation between the Brahmins of Samatata and the Other Hindus of Samatata.

(*d*) The variation in the Cephalic Index between the Brahmins of Vanga and the Other Hindus of Samatata is smaller than the variation between the Brahmins of Samatata and Other Hindus of Samatata.

Can we apportion the exact part played by each of these factors in the formation of the variations? To this question there is at present no answer and none will be forthcoming until an Einstein of Biology is matured in the womb of time.

It may seem a pity that so much time and toil should have been spent in trying to elucidate a problem which in the final analysis baulks solution. But if we look at the problem from another angle quite a different picture emerges. In our search for variations we have been baffled time and again by the mass of resemblance shown by the different groups in the different zones. The complete graphs for the Cephalic Index for the different zones are published in Diagrams Nos. 2, 3 and 4. The graphs for the zones Radha, Vanga and Varendra show a single peak at 78.5 and the left halves are almost similar to the right halves. In fact they run so closely together most of the way that for all practical purposes they may be regarded as identical. The graphs for Samatata and Calcutta, Diagram No. 3, are also strikingly similar. Apart from a shifting of the peak from 78.5 to 80.5, probably a result of brachycephalisation *in situ*, there is little to differentiate them from the graphs for the zones Radha, Varendra and Vanga. The graph for Chattala is completely different with peaks at 72.5, 75.5, 78.5, 80.5 and 85.5, probably indicating the segregation of the factors for head shape. So it seems that it is only in the border zone of Chattala that the variations manifest themselves to any perceptible degree. The Delta or Samatata including Calcutta is well on the way to achieve homogeneity and the zones Radha, Varendra and Vanga have achieved a degree of homogeneity that is remarkable. To what factors then may we attribute these remarkable resemblances ? It may be that in Bengal the institution of caste is a later development imposed upon a people who

were well on the way to achieve homogeneity. The consideration of this problem is beyond the pale of physical anthropology and falls into the domain of social history. Or, it may be that environmental conditions have in the past moulded and are still moulding the stature and head shape of the people of Bengal to produce a common biological type.

Whatever may be the ultimate answer to the questions suggested above the fact that a great degree of homogeneity exists among the Bengalees can not be gainsaid. This is a conclusion of the utmost importance. At the present moment they are faced with the immediate and urgent problem of orienting their society to suit the needs of a frontier people. The linguistic and cultural bonds which bind them together will be further strengthened by the realisation of the ethnic unity shown above and may help them to a certain extent to achieve more quickly and more smoothly the transition to a casteless and creedless society essential for the ushering in of the brave new Bengal of our dreams, a united, mighty, prosperous and progressive Bengal, which will be a living embodiment of the gospel of peace on earth and goodwill to man.

Thus with much doubt and many denials the investigator at last gains a viewpoint from whence he dimly sees the emergence of a united people, only to find that the poet, with his prophetic vision, has long anticipated him in the quest and he can do no better than close his address with the memorable lines from Rabindranath :—

হেথায় আর্য্য, হেথা অনার্য্য,
হেথায় দ্রাবিড়, চীন,
শক, হুন দল, পাঠান মোগল,
এক দেহে হ'ল লীন।

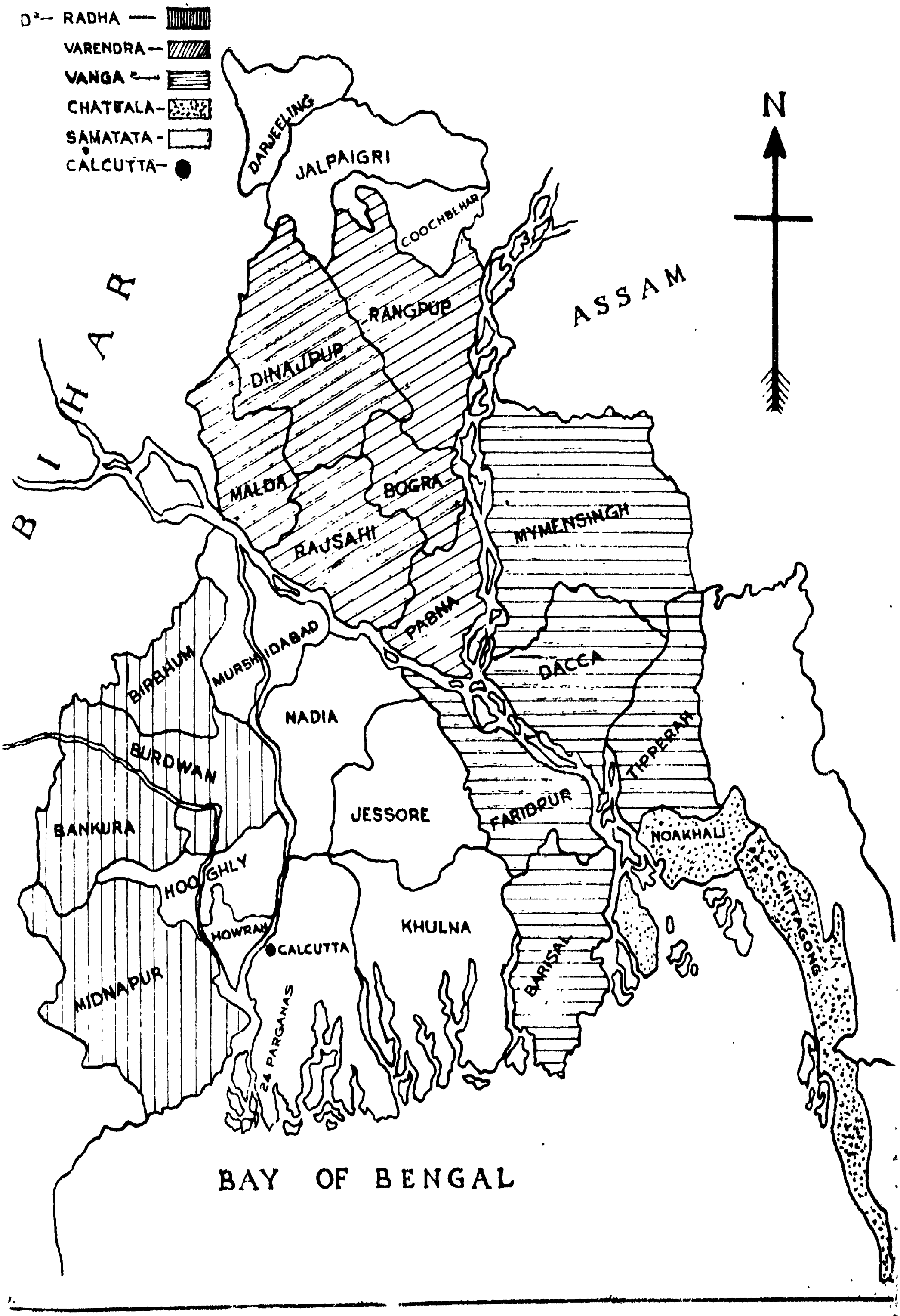

RADHA
VARENDRA
VANGA
CHATTALA
SAMATATA
CALCUTTA
N
BIHAR
ASSAM
DARJEELING
JALPAIGRI
COOCHBEHAR
RANGPUR
DINAJPUR
MALDA
BOGRA
RAJSAHI
MYMENSINGH
PABNA
MURSHIDABAD
BIRBHUM
NADIA
DACCA
BURDWAN
TIPPERAH
BANKURA
JESSORE
FARIDPUR
NOAKHALI
HOOGHLY
CHITTAGONG
HOWRAH
CALCUTTA
KHULNA
MIDNAPUR
24 PARGANAS
BARISAL
BAY OF BENGAL

DIAGRAM 2

Calculated incidence of Cephalic Index per thousand of the population.

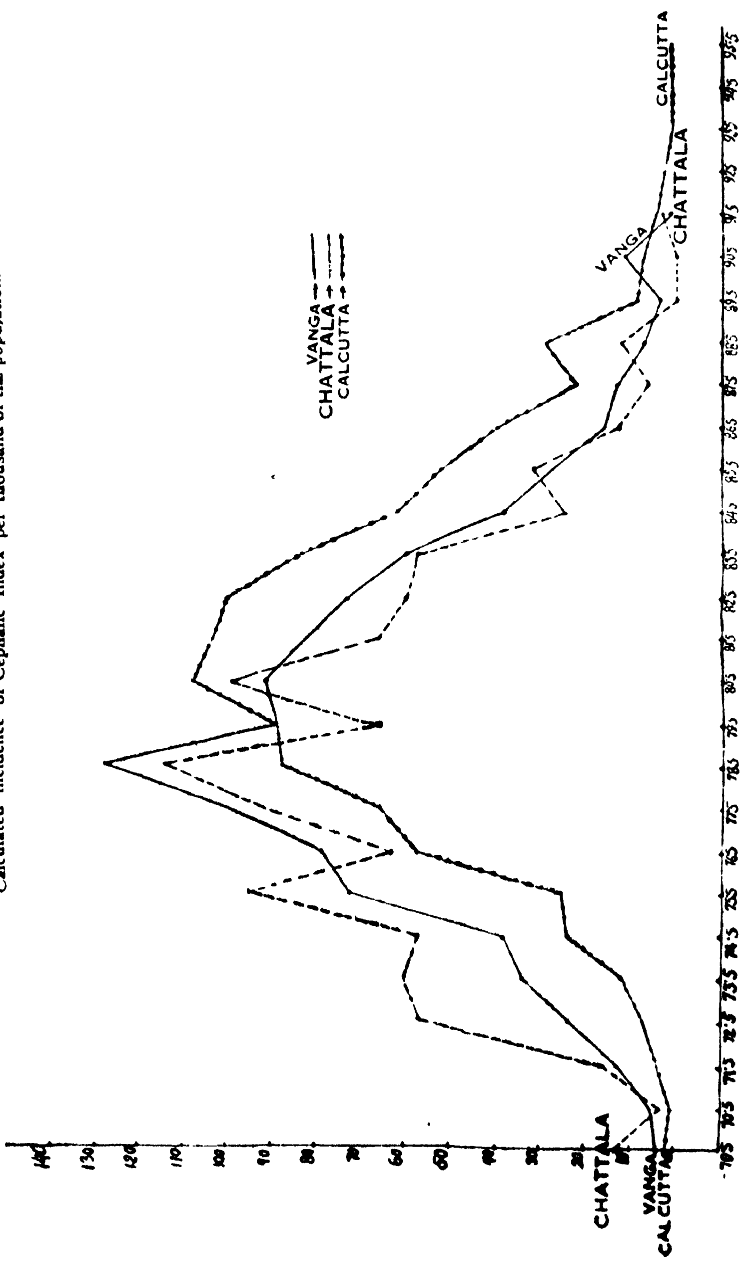


DIAGRAM 3.

Calculated incidence of Cephalic Index per thousand of the population.

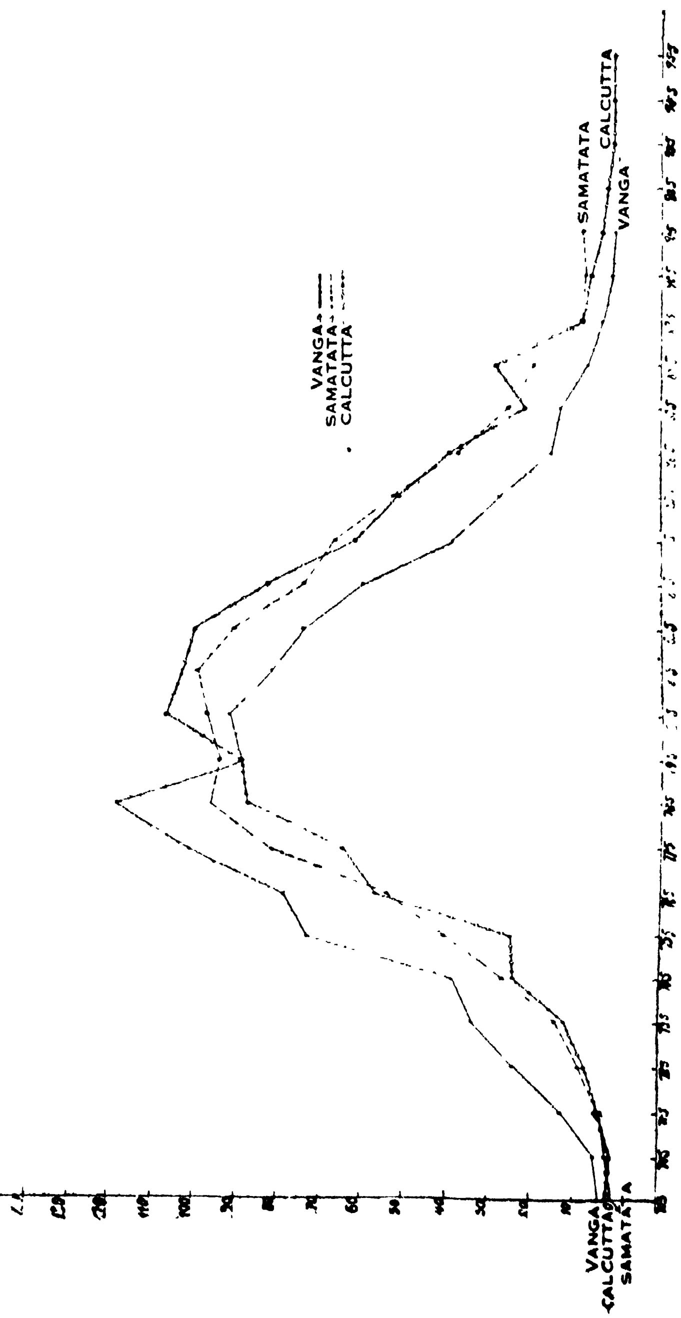
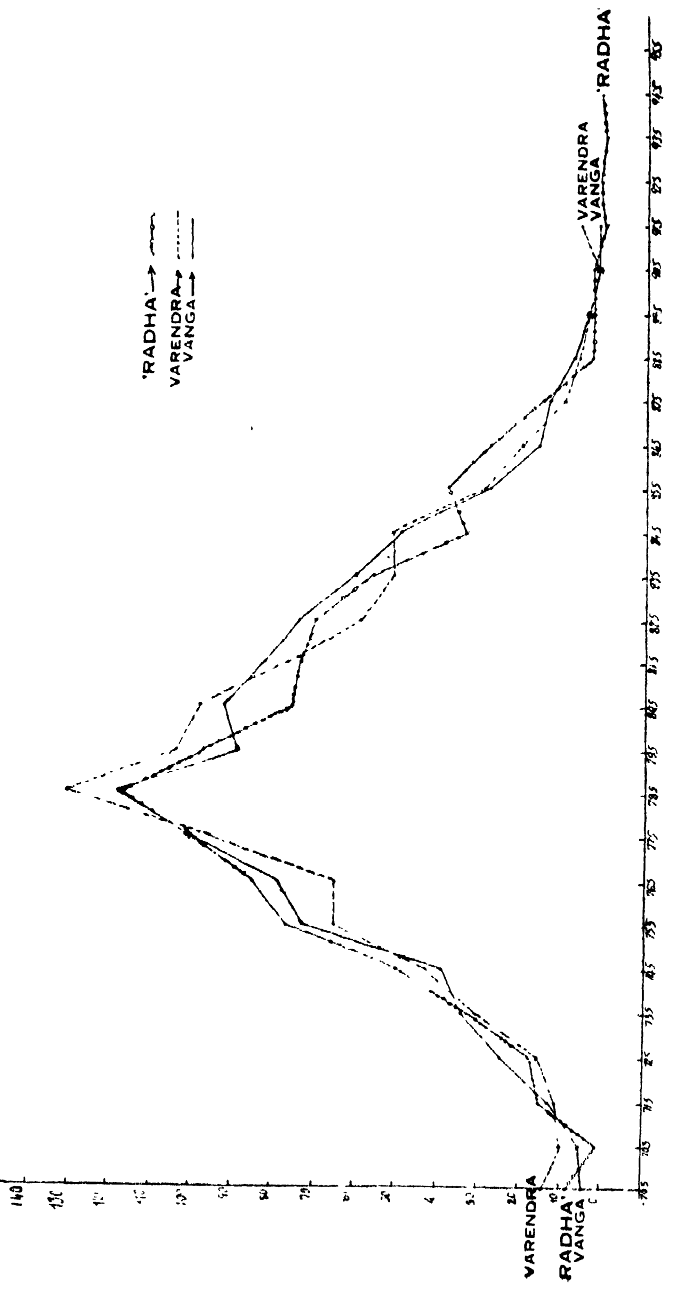


DIAGRAM 4

Calculated incidence of Cephalic Index per thousand of the population.



SECTION OF STATISTICS

President—Mr. S. N. Roy, M.Sc., F.N.I.

Presidential Address

N OUTLINE OF SOME MODERN THEORIES OF STATISTICAL INFERENCE

(*Delivered on January 3, 1948*)

I take it that after some of the really distinguished men in the field in India have had their turns, the choice for the Presidentship of the Section this year has descended on one who is merely among the numerous humdrum workers—one who has moved about in a particular corner of the science, useful though that corner is supposed to be.· Presumably not quite unnatural at any time, this is perhaps inevitable at a time when all sections and interests are sought to be given some say through representatives, important or unimportant, and in any discussion the net is sought to be flung far and wide.

General Introduction

Within the last thirty years in particular statistical inference has acquired a technical sense which is more or less understood by workers in various branches of statistical science, but is not perhaps so well-known to workers belonging to the different cognate sciences. While statistical inference is conceived in the realm of probability and expressed in the language of probability, all probability statements, in fact many of the usual types, are not statistical inference. Awareness of the central problem here and attempts at a solution of it can be traced as far back as Bayes' theorem and the investigations associated with it, in which various mathematicians and statisticians of the last couple of centuries including Laplace himself have had their share. Inferences made from a sample of actual observations—either pure random or random under qualifications—about the universe sampled, form the subject matter of this branch of statistics. Such inferences have two distinctive features which place them in a certain class among inferences in general. In the first place they relate to group or class properties of the universe sampled and are not concerned with specific individuals as such. In the second place—and it is here that a good deal of reorientation has come about since Bayes' epoch—they are expressed in the form of probability statements in which the probability is not related to the truth or otherwise of the particular inferences themselves as among a totality of possible inferences, but to the capacity of the sampling procedure to hit or miss the inference, if it were assumed to be the right one, or to discriminate as amongst possible inferences, when one might be right and the others wrong, in general to the position of the sampling procedure vis-a-vis the particular inference or the totality of possible inferences. The description of the universe (sampled) in terms of a frequency or probability distribution of one or more characters is technically called a statistical population and the batch of individuals actually observed and labelled in terms

of the character or characters is called a statistical sample. While the physical operation involves a passage from the population to the sample, statistical inference involves in a certain sense a retracing of the steps and a conceptual passage from the sample to the population. Probability statements, whether made in the context of the first passage or of the second one, relate, however, in either case to the sample or samples. As observed earlier, this, while well-known to statistical workers, is likely to be often missed by workers in other domains where statistical tools might be needed.

This talk will be confined to the modern technique of statistical inference of which by far the greater part has developed within the last 25 years or so. The rudiments of the technique can, however, be traced back to the work done towards the end of the 19th century and the first quarter of the 20th by Karl Pearson and his school along three different lines (to the first of which the Scandinavian school has also contributed methods of their own). (i) The first line of development has been the evolution (in which the Scandinavian school has also shared with systems and methods of their own) of a fairly flexible system of frequency curves for statistical descriptions of univariate universes, and a method of graduation of observed frequency data in terms of such curves, or, in other words, a procedure for statistical inference about such universes in the light of observations ; (ii) the second line is concerned with more than one variate and a study of the nature of the connection between such variates. Here, apart from the evolution of some suitable frequency laws for purposes of graduation, the most outstanding contribution of Karl Pearson's school has been the development (from an earlier and rudimentary state) of the concept of statistical association between two or more statistical variates and suitable measures of it, appropriate at any rate to certain special but important situations. This statistical association is a logical extension of the older notion of causal connection which was naturally found much too rigid in many domains of the physical world. (iii) The third line which, in the progress of science, has been equally fruitful, is concerned with a technique of judging any hypothesis in the light of observations when the frequency distributions, whether under the hypothesis or for the actual observations, are over classes which might be either qualitative or quantitative, the technique, however, being especially suited to the former case. The third line is concerned with the manner of inference, the first with both manner and matter, while the second is mostly concerned with the matter in situations involving multiplicity of factors. Within the last thirty years the subject has no doubt made enormous strides leaving the older signposts far behind, but in course of this development much of the earlier work has played a significant role. As in other sciences so also here, the urge behind the older techniques has been self-propagating, while an awareness of their inadequacy has been an incentive to perpetual and fruitful modifications.

The purely modern epoch may be perhaps said to have started with the work of Fisher and his school. It was recognised quite early that there are really two facets to the main problem, one relating to the manner of collection of the sample suited to the requirements of the particular type of inference or hypothesis, and the other relating to the best utilisation of the data collected, for purposes of the inference. The first one which concerns the pre-sampling stage has come to be technically known as the theory of planning or design of experiments while the second one is called the theory of proper analysis or interpretation of such data. In his presidential address to the section of statistics of the last science congress Prof. R. C. Bose gave a full and adequate account of the first aspect of the general problem and the steps taken in the direction of a solution. He dealt

also with the second aspect, specially those parts of it more intimately related to the first one. The present talk, therefore, will be mostly concerned with the broad outlines of the second aspect with a slightly more detailed reference to such points as have occurred to the speaker in recent years. In giving a sketch of the modern theory the historical order which perhaps gives greater insight into the processes of evolution of the theory, will be followed rather than the purely logical order, which, while showing the earlier results to be mere special cases of the later results, does not, however, quite bring into prominence the psychological routes of generalisation. Exceptions, nevertheless, will be made in certain cases to avoid undue repetition. In this development three land-marks are noticeable, (*i*) the theory of estimation due to Fisher and his school, (*ii*) the theory of testing of hypothesis and of estimation by confidence intervals due to Neyman and Pearson, Neyman, and their school, and finally (*iii*) the unified and general theory of statistical inference due to Wald and his school.

We can start from a set of n stochastic variables $(x_1, x_2, \ldots x_n)$ sometimes written for shortness as $(x^{(n)})$ with a probability distribution

$\phi(x_1, x_2, \ldots x_n \,;\, \theta_1, \theta_2, \ldots \theta_k) \prod_{i=1}^{n} dx_i$ (in the case of continuous variables)

and simply $\phi(x_1, x_2, \ldots x_n \,;\, \theta_1, \theta_2, \ldots \theta_k)$ (in the case of discrete variables), the expressions being sometimes written for shortness as $\phi\{(x^{(n)}) \,;\, (\theta^{(k)})\}d(x^{(n)})$ and $\phi\{(x^{(n)}) \,;\, (\theta^{(k)})\}$ respectively. For continuous variables ϕ is called the probability density. If it takes the form $\prod_{i=1}^{n} f(x_i \,;\, \theta_1, \ldots \theta_k)$ we have the special but very important case of n random and independent observations from a population of the form $f(x \,;\, \theta_1, \ldots \theta_k)$. In this set-up the main objectives in the case of any general ϕ can in the first instance be formulated as (*i*) guess about ϕ covering both its form and the parameters $(\theta^{(k)})$ this guess being made in the light of $(x^{(n)})$ of which a special but important case is (*ia*) guess about $(\theta^{(k)})$ assuming ϕ to be a known form, and (*ii*) testing again on the basis of $(x^{(n)})$ any hypothesis concerning ϕ—both form and $(\theta^{(k)})$—of which a special case is (*iia*) testing any hypothesis about $(\theta^{(k)})$ assuming the form of ϕ to be known. For each of the cases (*i*), (*ia*), (*ii*), (*iia*) the central problem is to devise an optimum procedure for reaching the objective. A prerequisite for this is that the optimum itself has to be defined; and it has been naturally defined by all theorists in terms of properties of the probability function itself. The guess (*i*) and (*ia*) may be either specific or broad, the latter denoting that ϕ is to be assigned to a class (discrete or continuous) instead of being assigned a particular form. Likewise, testing hypotheses (*ii*) or (*iia*) may also be either specific or broad in the same sense as indicated for (*i*) and (*ia*). The earliest attempts at a solution of (*i*) were due to Karl Pearson's school and the Scandinavian school. By the very nature of things this could not but be very rough at that stage. Since then some further progress has been made in this direction particularly in recent years, but even to-day, owing no doubt to the very great difficulties—both mathematical and conceptual-the subject remains in a very rudimentary stage of development. Coming now to (*ia*), it was Fisher who first set out to attack the problem in the case of a specific guess, and developed what may conveniently be called a theory of *point estimation.* While his definite objective was limited to this particular situation, the concepts and technique that he introduced were, however, to prove of far wider significance and usefulness, covering in fact the whole domain of statistical

inference. This is but another example of a phenomenon met with in various other branches of positive sciences. Fisher later attacked the problem (*ia*) in so far as the guess might be broad instead of specific, but in this he introduced concepts and methods based on what he called ***fiducial probabilities*** which are perhaps a little outside the domain of orthodox probability. Partly for this and partly because his methods in this regard do not fit into the general scheme considered here, his procedure in this situation will not be discussed in the present talk. Neyman and Pearson and their school attacked the problems (*ii*) and (*iia*) with special stress on (*iia*) both for specific and for broad hypothesis. The concepts and methods used were before long utilised by Neyman to attack the problem (*ia*) for broad guess or what is technically known to-day as estimation by *confidence intervals*, which will be discussed in course of this talk. Turning again to (*iia*) a specific hypothesis is termed a *simple hypothesis* and a broad one a *composite hypothesis*. Tests of composite hypothesis in various particular cases had pretty long been in use but it was Neyman and Pearson who first made a systematic investigation of the nature of the problem and the conditions and nature of possible solutions and the basis for a choice of the optimum amongst them. This concept of a composite hypothesis and a suitable technique for testing it could well and perhaps may have in fact suggested that the guess under (*i*), and the hypothesis under (*ii*) might be also in other ways relaxed from 'specific' to 'broad', and further that (*ii*) might by proper adustments be broadened to include the so called 'non-parametric' cases of testing of hypothesis on which a good deal of work has been done in recent years and of which the most outstanding early example was the χ^2-test already mentioned under the third line of work done by Karl Pearson's school. To Wald and his school is due a general theory of statistical inference, conceptually and philosophically adequate, but mathematically and physically yet evolving, in which the problems posed under (*i*), (*ia*) as well as under (*ii*) and (*iia*) are supposed to be either specific or broad (as indicated earlier), and are then fused together after some further generalisation in content. To this school is also due another important development in statistical inference, now known as sequential analysis which, unlike all earlier theories based on samples of a fixed number n, involves a procedure in which observations are taken one after another, whether the succeeding observaton is to be taken at all being dependent on what the preceding observations have been like. The progress achieved so far seems to be but the beginning of a fruitful process projecting far into the future, of which, apparently, the end is yet a long way off.

§ I. Preliminaries

Certain notions and definitions might be introduced at this stage as a preliminary to the development of the general theories. If

$$\phi(x_1, x_2, \ldots x_n\ ;\ \theta_1, \theta_2, \ldots \theta_k) \text{ be of the form}$$

$$\phi_1(T_1, T_2, \ldots T_m;\ \theta_1, \theta_2, \ldots \theta_k)\ \phi_2(x_1, x_2, \ldots x_n) \qquad ..(1)$$

where $T_i = F_i(x_1, x_2, \ldots x_n)$ with $i=1, 2, \ldots m (m<n)$ ..(1.1)

then the set $(T_1, T_2, \ldots T_m)$ which might be denoted by $(T^{(m)})$ is called a shared sufficient set of statisites for the parameters $(\theta^{(k)})$. It may be that $m >$ or $=$ or $< k$. A case of great physical interest is where $k=m=1$,

when $\quad \phi=\phi_1(T;\theta)\phi_2(x_1, x_2, \ldots x_n)$ ..(1.2)

with $\quad T=F(x_1, x_2, \ldots x_n)$ ..(1.21)

In this case T is called a sufficient statistic for θ. Either (1) or (1.2) is a fairly stringent restriction on ϕ, which means that sufficient statistics would not be often available. Two interesting properties of sufficiency, whether in relation to (1) or (1.2), may be noted here.

(*i*) If $(T^{(m)})$ is a shared sufficient set then $(U^{(m)})$ where $U_i \equiv f_i(T^{(m)})$ (with $i=1,2,\ldots m$) will also be a shared sufficient set, and in particular if T is a sufficient statistic then any function of T will also be such. (*ii*) There cannot be any shared sufficient set $(T^{(m)})$ which is not of the form $U_i \equiv f_i\,(T^{(m)})$ and any sufficient U which is not a function of T. The original definition of Fisher was physically more illuminating but less tractable. (1.2) has since been shown to be exactly equivalent to the original definition, and (1) is merely a proper generalisation of (1.2), retaining the main concepts.

The next preliminary is the likelihood concept. 'ϕ' regarded as a function of $(x^{(n)})$ may be called probability density function (for continuous stochastic variables). This same ϕ regarded as a function of $(\theta^{(k)})$ has been called the 'likelihood function'. That way it has certain interesting properties to be discussed later. Given $(x^{(n)})$ the unique values of $\hat{\theta}_i (i=1, 2, \ldots k)$ in terms of $(x^{(n)})$ that is,

$$\hat{\theta}_i = \hat{\theta}_i\,(x_1,\ x_2,\ \ldots x_n)(i=1,\ 2,\ \ldots k) \qquad ..(1.3)$$

which maximise ϕ (provided that such maximum exists) are known as the respective maximum likelihood estimates of $(\theta_1,\ \theta_2,\ \ldots\ \theta_k)$. When $k=1$ such a unique θ would exist under certain mild restrictions and would be by definition a maximum likelihood estimate of θ. This means that a maximum likelihood estimate would be much more often available than a sufficient statistic.

§ 2. Fisher's Theory of Point Estimation

Fisher's theory of point estimation may now be taken up and for simplicity (without much essential loss of generality) the discussion may be confined to only one parameter.

The criteria defining the 'optimum' and providing a basis for its choice are :

(a) *Consistency.* Let $\{T(n)\}$ denote a sequence of functions, the n-th one being based on a sample of size n, and all being of the same form. Then, given arbitrary small positive numbers (ϵ,η), if an $n_0(\epsilon,\eta)$ can be found such that

$$P\{\,|T(n)-\theta|\leqslant\epsilon\}>1-\eta \text{ if } n\geqslant n_0(\epsilon,\ \eta) \qquad ..(2)$$

then the sequence $\{T\ (n)\}$is said to stochastically converge to θ, or T is said to be a consistent estimate of θ. While ruling out many statistics it will also admit quite a numerous class of estimating statistics.

(b) *Efficiency.* Among the class of statistics fulfilling (2), the further choice of (if possible) one by elimination of the others is guided by the consideration of rapidity of stochastic convergence, or, if we look at it in a slightly different way, the stability of judgment. Consider an important subclass of the class satisfying (2), which fulfils the further condition that $\sqrt{n}\ (T(n)-\theta)$ is approximately normally distributed with a finite variance. ..(2·1)

This is related to 'Laplace's central limit tendency theorem' and would hold whenever T(n) could be written as the sum of n stochastic variables (not necessarily the original set of $x_1,\ x_2,\ \ldots x_n$) being only subject to those

conditions under which Laplace's theorem holds. The condition, therefore, while more restrictive than for (2) is yet not very stringent. Then, if there is a sequence $\{T(n)\}$ such that for large n and for any other $\{T'(n)\}$ fulfilling (2.1)

$$E|\sqrt{n}(T(n)-\theta)|^2 = \sigma^2 \leqslant E|\sqrt{n}(T'(n)-\theta)|^2 = \sigma'^2 \qquad ..(2\cdot 2)$$

T is said to be an efficient statistic (for estimating θ) and the efficiency of any other statistic T′ is measured by $\sigma^2/\sigma'^2 \leqslant 1$. There might be more than one such satisfying (2.2). Among the sub-class satisfying (2.1), that or those satisfying (2.2) would obviously have the greatest rapidity of stochastic convergence given by (2) and would thus be optimum. This is because, for the normal law, probability is immediately and in a very simple manner related to variance or corrected second moment. Criterion (2.2) may even be offered for those statistics not satisfying (2.1), but for any probability law other than normal,probability would not be related to variance by an exact, simple and general rule but by an inequality relation given by Tschebycheff's theorem which would not provide an exact basis of choice as amongst rival estimating statistics.

Criterion (2) is subject to the limitation that it is an essentially large sample concept under which we admit an estimating statistic even on small samples if it behaves in a particular manner on a large sample. Criterion (2.2) which again is a large sample concept, besides the limitation of (2.1), suffers from the further limitation that although properly speaking, we should say that $T(n)$ is not worse than $T'(n)$ as based on a large n, we speak nevertheless of T not being worse than T′ even for small n.

A criterion which, while retaining the basic concept of efficiency, becomes free from large sample assumptions was thus called for and was actually supplied by Fisher. This will be taken up at a slightly later stage. Meanwhile turning to (2.2), we may note that if there are T and T′ not necessarily satisfying (2.1), of which T satisfies (2.2) while T′ may or may not, then the correlation coefficient between T and T′ is equal to σ/σ'. We turn next to the relationship between sufficiency and maximum likelihood statistic on one hand and the criteria (2) and (2.2) on the other hand. (*i*) For sufficiency we note that if (1.2) holds we can usually choose a suitable function of T (which itself would be by definition a sufficient statistic and may be called T without any loss of generality) which satisfies (2) ; in this sense we may say that a sufficient statistic is also consistent. (*ii*) We note further that a sufficient statistic under certain mild restrictions is also efficient in the sense of (2.1) and (2.2). For maximum likelihood we note that under certain conditions neither too mild, nor too restrictive the maximum likelihood statistic is both (*iii*) consistent, and (*iv*) efficient in the sense of satisfying both (2.1) and (2.2). Condition (*iv*) thus enables us to (a) test whether a given statistic satisfying (2) and (2.1) is also efficient, (*b*) if not, what is its efficiency, and furthermore (*c*) gives us a simple procedure for getting hold of an efficient statistic. It may be noted that neither (*a*), nor (*c*) would be forthcoming from (2.2) as such. The fact that the maximum likelihood statistic possesses these properties is, therefore, of the greatest practical significance. As between the sufficient statistic T (if (1.2) holds) and the maximum likelihood statistic $\hat{\theta}$ we note that a consistent sufficient statistic(if it exists at all) coincides with the maximum likelihood estimate. Part of the large sample theory of efficiency, for instance the optimum properties of the maximum likelihood statistic, rests on the further assumption that the variance of the estimating statistic

s free from the parameter—a more stringent assumption than the mere large sample normality condition.

To take up next the problem stated at the beginning of the last paragraph, Fisher generalised the large sample concept of efficiency to a small sample concept with a quantitative measure which he called 'information' and which is given by

$$\left.\begin{aligned} \mathrm{I}\ (\text{sample}) &= -\mathrm{E}\left(\frac{\partial^2}{\partial\theta^2}\log\phi\right) = \mathrm{E}\left(\frac{1}{\phi}\frac{\partial\phi}{\partial\theta}\right)^2 \\ \mathrm{I(T)} &= -\mathrm{E}\left(\frac{\partial^2}{\partial\theta^2}\log\psi\right) = \mathrm{E}\left(\frac{1}{\psi}\frac{\partial\psi}{\partial\theta}\right)^2 \\ \mathrm{I}\ (\text{single observation}) &= -\mathrm{E}\left(\frac{\partial^2}{\partial\theta^2}\log f\right) = \mathrm{E}\left(\frac{1}{f}\frac{\partial f}{\partial\theta}\right)^2 \end{aligned}\right\} \quad ..(2{\cdot}3)$$

where the probability functions for T and x are ψ(T) and $f(x)$ respectively. This I possesses a set of remarkable properties :—(a) Under the large sample normality assumption (2.1) for T(n), I(T) = 1/variance of T, (b) I(sample) $\geqslant$ I (single observation) $\geqslant$ 0 and $= \Sigma\, \mathrm{I}\,(x_i)$ if the stochastic variables are independent, and $= n\mathrm{I}(x)$, if further each of the stochastic variables follows the same probability law, i.e. if they are a random sample from the same population, (c) I (sample) $\geqslant$I(T)$\geqslant$0 the first inequality being an equality when and only when (1.2) is satisfied, i.e. when T is a sufficient statistic. The small sample efficiency of any statistic may be defined as *Eff.* (T)=I(T)/I (sample)$\leqslant$1, there being equality if T is a sufficient statistic. We may further define an L(T) by {I(sample)−I(T)}/I (sample). Properties (a) and (b) justify the name information being given to expressions (2.3), and property (c) justifies the name 'sufficiency' being given to the condition (1.2). This has been all proved. It is conjectured but has not yet been fully proved that when there is no sufficient statistic, then under certain mild restrictions, (α)L($\hat{\theta}$)$\leqslant$ L (any other statistic), and further that in small samples

L($\hat{\theta}$) $<$ L (any other large sample efficient statistic)

$<$ L (any large sample inefficient statistic)$<$1, while as $n\to\infty$,

L($\hat{\theta}$)$\to$L (any other large sample efficient statistic)$\to$0, but

L (any large sample inefficient statistic)$\to q>0$.

Extension of the theory to the multiparametric cases do not involve any radical change in the concepts. Necessary adjustments in the mathematical procedures will be needed, but need not be discussed here. The only point of interest worth mentioning here is the possibility of a concept like co-information for parameters θ_i and θ_j which can be expressed in terms of the information matrix.

$$\left(-\mathrm{E}\left[\frac{\partial^2\log\phi}{\partial\theta_i\,\partial\theta_j}\right]\right) \quad ..(2{\cdot}4)$$

For uniparametric cases the recent developments of the theory of point estimation have been along two lines, (i) generalisations of expressions (2.3),

while retaining properties (*a*), (b) and (c), and (*ii*) generation by operations (including differentiation) on ϕ of statistics with minimum variance when $\hat{\theta}$ itself may not be such, no matter whether the sample is small or large and if large, whether the large sample normality condition is satisfied or not. While a great many interesting results have been evolved we have to refrain from including them in this sketch partly for shortness of space and partly because such developments do not affect the main outlines of the scheme as conceived here. Similar remarks would apply in the main to the developments in the multiparametric cases.

§ 3. Neyman and Pearson's Theory of Testing of Hypothesis

A. General

Neyman and Pearson's theory of testing of hypothesis may be taken up next. If the possible alternative hypotheses concerning ϕ can be assumed to belong to a class Ω, and if H_0 be the particular hypothesis in question while H is any other alternative (both belonging to Ω), then ϕ_{H_0} and ϕ_H will be the respective probability laws. A sample $(x_1, x_2, \ldots x_n)$ or $(x^{(n)})$ will be represented by the point E_n in the sample space which will represent the domain of the totality of all possible samples. Any subdomain or subspace will be represented by $(W^{(n)})$, E_n lying in $W^{(n)}$ will be denoted by $E_n \epsilon W^{(n)}$, and the probability of such a thing happening on the hypothesis H will be denoted by $P(E_n \epsilon W^{(n)}/H)$. The procedure here consists in a rule or test based on any region $W^{(n)}$ (to be called the critical region) such that (*i*) if $E_n \epsilon W^{(n)}$ we reject H_0, (*ii*) if E_n not ϵ $W^{(n)}$ we accept H_0. The rule is judged in relation to any alternative H keeping in view the possibility of H_0 being false and H being true. The criterion, in this situation, defining the 'optimum' and providing a basis for its choice are that (a) the rule or test must be such that chance of rejection of H_0 when it is right must be equal to a preassigned $\alpha(<1)$, (b) by the test or rule the chance of rejection of H_0 when it is right must not be greater than its chance of rejection when it is false and H is true and lastly, (c) when H_0 is wrong and H is right, the chance of rejection of H_0 by this test must not be less than the corresponding chance by any other test satisfying (a).

In symbols

$$(a) \quad P(E_n \epsilon w^{(n)}/H_0) = \alpha \qquad ..(3)$$

$$(b) \quad P(E_n \epsilon w^{(n)}/H) \geqslant P(E_n \epsilon w^{(n)}/H_0) \text{ i.e. } \geqslant \alpha \qquad ..(3{\cdot}1)$$

$$(c) \quad P(E_n \epsilon w^{(n)}/H) \geqslant P(E_n \epsilon W^{(n)}/H) \qquad ..(3{\cdot}2)$$

for any other $W^{(n)}$ satisfying (3).

Any $W^{(n)}$ satisfying (3) is called a *critical region of size* α; if it satisfies (3.1) the associated test is called an *unbiassed test* of H_0 with respect to the alternative H; if it satisfies (3.2) the associated test is called a *most powerful test* of H_0 with regard to the alternative H.

It has been shown that a region $w^{(n)}$ defined such that

$$\left.\begin{array}{ll} \text{inside } w^{(n)}: & \phi_H \geqslant \lambda\, \phi_{H_0} \\ \text{outside } w^{(n)}: & \phi_H < \lambda\, \phi_{H_0} \end{array}\right\} \qquad ..(3{\cdot}3)$$

where λ is chosen such that (3) is satisfied, is one which (usually unique) satisfies (3.1) and also (3.2) in relation to all alternative

regions $W^{(n)}$ satisfying (3). This, therefore, provides an unbiassed and most powerful test of H_0 with regard to the alternative H. The location of this optimum critical $w^{(n)}$ in the sample space depends, therefore, upon both H_0 and H (apart from α), and may be denoted by writing $w^{(n)}$ as $w^{(n)}$ (α, H_0, H). The λ of (3.3) also depends on α, H_0 and H and this dependence also can be sometimes conveniently expressed by putting $\lambda = \lambda(\alpha, H_0, H)$. Such a region is almost always available.

Turning to (3.3) we note that if (as will not often happen) the location of $w^{(n)}$ defined by (3.3) becomes free from H i.e., if it depends only on α and H_0 and can thus be written as $w^{(n)}(\alpha, H_0)$, we have a region which, while located independently of H, satisfies all the conditions (3)-(3.2) for all H within the domain of alternatives Ω; such a region or rather the associated test may be called (after a slight extension of Neyman's terminology) a uniformly unbiassed and uniformly most powerful test for all alternatives within the domain Ω. For the so-called parametric cases where the class of alternatives relate to the set $(\theta^{(k)})$ the form ϕ being assumed, such a test may be available depending upon the form of ϕ but when the class of alternatives might involve variation of ϕ as well, or might belong to the other so-called non-parametric cases such a test may not perhaps exist at all.

BI. Parametric Cases—Simple Hypothesis

Turning to the parametric cases, i.e. those in which ϕ is assumed while the class of alternatives relate to the set $(\theta^{(k)})$ we may note several important results and developments. Consider now the nature of the relationship between power of a test and sufficiency (if it exists at all) on one hand and likelihood on the other hand. For this purpose we can (without unduly affecting the generality of the results) consider for simplicity the case of one parameter alone, i.e. when the set $(\theta^{(k)})$ is simply θ.

(i) It has been shown that if (for estimation of θ) a sufficient statistic T as defined by (1.2) exists then under certain mild restrictions it will also provide a uniformly unbiassed and uniformly most powerful test for H ($\theta = \theta_0$) at any rate one such with regard to the class of alternatives $\theta > \theta_0$ and another for $\theta < \theta_0$ or perhaps different tests for different subdomains of the Ω domain. Likewise if a uniformly most powerful and unbiassed test exists in the sense just indicated, then under certain other mild restrictions a sufficient statistic would exist, and the one will be based on the other. Extensions of this to several paremeters do not present any further conceptual difficulties but may give rise to mathematical intricacies. This will not be discussed here.

(*ii*) It has been already observed that when a sufficient statistic exists it coincides with the maximum likelihood statistic. The relationship of 'maximum likelihood' with 'power' is therefore in this case quite clear. When however, a uniformly most powerful and unbiassed test does not exist it has been shown that an interesting property is possessed by the domain $W^{(n)}(\alpha_0, \theta_0, \hat{\theta})$ (depending upon α_0, θ_0, $\hat{\theta}$, the latter being not a parameter but a function of $(x^{(n)})$ which means that the form of the function $\hat{\theta}$ is what affects the location of $W^{(n)}$) which is defined by

$$\phi\{(x^{(n)})\ ;\ \theta_0\} \geqslant \lambda_0 \phi\{(x^{(n)})\ ;\ \hat{\theta}\} \qquad ..(3\cdot31)$$

where λ_0 is so chosen as to satisfy $P\{E_n \epsilon w^{(n)}/\theta_0\} = \alpha_0$ ..(3·32)

whence λ_0 may be written as $\lambda_0(\alpha_0, \theta_0)$. ..(3.33)

This dependence is also related to the form of $\hat{\theta}$. The boundary of this domain is the envelope of the boundaries of the different unbiassed and most powerful critical regions $w^{(n)}(\alpha, \theta_0, \theta)$ (with regard to the different alternatives θ) defined by (3.2). But the variation which generates the envelope is in such a sense as to make this property physically inconsequential. The envelope is based on variation of *both* α and θ in such a manner as to keep $\lambda(\alpha, \theta_0, \theta) = \lambda_0(\alpha_0, \theta_0)$ where α_0 is a preassigned level of significance. If the envelope were obtained with α being fixed at α_0 this would have been a property of remarkable physical significance. As it is, the property is rather academic. We can have without undue difficulties a similar extension to the case of several parameters.

We may take up now another important development for the parametric case. Here again we may in the first instance keep to one parameter θ. If no uniformly most powerful and unbiassed test for, say, $H(\theta = \theta_0)$ exists we can have in this situation, besides the tests based on regions $w^{(n)}$ defined by (3)–(3.2), another kind of optimum test (available under certain mild restrictions) which may be said to be locally unbiassed and locally most powerful, i.e. unbiassed and most powerful for all alternatives θ in the neighbourhood of θ_0. Assuming continuous stochastic variables and a ϕ which is integrable over $(x^{(n)})$ and is also such that differentiation with regard to θ under integration over $(x^{(n)})$ is permissible, such a test would be given by a region $w^{(n)}(\alpha, \theta_0)$ defined by

$$\left[\frac{\partial^2}{\partial\theta^2}\phi\{(x^{(n)}) ; \theta\}\right]_{\theta=\theta_0} \geqq \lambda_1\phi\{(x^{(n)}) ; \theta_0\} + \lambda_2\left[\frac{\partial}{\partial\theta}\phi\{(x^{(n)}) ; \theta\}\right]_{\theta=\theta_0} \quad ..(3\cdot4)$$

where λ_1 and λ_2 are so chosen that

$$\int_{w^{(n)}}\phi\{(x^{(n)}) ; \theta_0\}d(x^{(n)}) = \alpha \; ; \; \int_{w^{(n)}}\left[\frac{\partial}{\partial\theta}\phi\{(x^{(n)}) ; \theta\}\right]_{\theta=\theta_0} d(x^{(n)}) = 0 \quad ..(3\cdot41)$$

The extension of this technique to the case of several parameters has not been of a general nature but has been subject to either of two alternative limitations. By this technique we can obtain a locally most powerful and locally unbiassed test (at the level of significance α) either

(i) among a class of tests (each at the level α) each of which is such that (a) (small) equal positive and negative deviations from the hypothesis for each parameter are equally discriminated, (b)(small) equal deviations of the different parameters are equally discriminated, and (c) the associated region $W^{(n)}$ satisfies the conditions

$$\int_{W^{(n)}}\left[\frac{\partial}{\partial\theta_i}\phi\{(x^{(n)}) ; (\theta^{(k)})\}\right]_{(\theta^{(k)}) = (\theta_0^{(k)})} d(x^{(n)}) = 0 \; (i = 1, 2, \ldots k) \quad ..(3\cdot42)$$

(It must be understood that the equality referred to under (a) and (b) is not as among the different tests belonging to the class considered, but, under each test, as among the different possibilities. This level of equality will of course be different for the different tests).
or

(*ii*) among a class of tests (each at the level α) each of which is such that (a) in the parametric space of $(\theta^{(k)})$ deviation of any particular magnitude

from the hypothesis $(\theta_0^{(k)})$ in any direction will be differentially discriminated by two such tests in a manner which is independent of either the direction or the magnitude of the deviation, depending only on the two tests in question and (b) the condition (3.42) is satisfied.

Such an optimum test either under (*i*) or (*ii*) possesses a lot of interesting invariance properties for certain classes of transformations of the k parameters $(\theta^{(k)})$ to new parameters $(\zeta^{(k)})$ which may be left out of the present discussion.

The reason why the investigations had to be limited to either of the two situations indicated in (*i*) and (*ii*) seems to be this. The fundamental problem posed in (3)-(3.2) as also the general problem here, which is the search for a most powerful and unbiassed test for all alterniatives $(\theta^{(k)})$ in the neighbourhood of the hypothesis to be tested $(\theta_0^{(k)})$, is really a problem in calculus of variations. By a remarkably elegant dodge the general technique of this calculus was by-passed in the case of (3)-(3.2) and a solution was obtained in terms of (3.3). Application of the technique associated with (3.3) or (3.4) may not perhaps be possible in the general multiparametric problem mentioned just now, but has been possible under the limitation (*i*) or (*ii*). The general problem here, free from the limitations (*i*) or (*ii*), really awaits a solution for purposes of which a more elaborate use of the 'calculus of variations' technique might be needed.

B2. Parametric Cases—Composite Hypothesis

We may consider now what is perhaps the most deeply significant part of the problem of testing of hypothesis as posed by Neyman and Pearson. It is the case of composite hypothesis, one in which the hypothesis concerning $(\theta^{(k)})$ is not specific but broad. Though mathematically difficult this is the problem met with in most practical situations, and that is why outstanding questions left over after Neyman's own significant contributions should receive more attention from research workers than they have till now attracted. The problem here is this. Suppose the set $(\theta^{(k)})$ belonging to a domain Ω is split up into two sets $(\theta_1, \theta_2, \ldots \theta_t; \theta_{t+1}, \theta_{t+2} \ldots \theta_{t+s})$ (where $k=t+s$) and the hypothesis is $(\theta_{t+i} = \theta^0_{t+i}; i=1, 2, \ldots s)$ no matter what $(\theta_1 \theta_2, \ldots \theta_t)$ may be within that domain Ω. This means that our hypothesis is such that $(\theta^{(k)})$ may lie in a subdomain of Ω in which θ_i's$(i=1, 2, \ldots t)$ may take any possible values in Ω but θ_i's$(i=t+1 \ldots t+s)$ have specific values. Such a hypothesis is called a composite hypothesis with t degrees of freedom. It would be evident on a little reflection that a test of such a hypothesis may not in many situations be available at all. Consider a hypothesis $H(\theta_{t+i}=\theta^0_{t+i})$ and an alternative $H(\theta_{t+i} \neq \theta^0_{t+i})$ $(i=1, 2 \ldots s)$, a pseudo-hypothesis $H(\theta_i = \theta^0_i)$ $(i=1, 2, \ldots t)$ associated with $H(\theta_{t+i} = \theta^0_{t+i})$, and an alternative pseudo-hypothesis $H(\theta_i \neq \theta^0_i)$ associated with $H(\theta_{t+i} \neq \theta^0_{t+i})$. We can of course get a region $W^{(n)}$ depending on $(\theta^0_1, \theta^0_2, \ldots \theta^0_t; \theta^0_{t+1}, \ldots \theta^0_{t+s})$ and α, which might be denoted by $W^{(n)}(\alpha; \theta^0_1, \ldots \theta^0_t; \theta^0_{t+1}, \ldots \theta^0_{t+s})$ such that over such a $W^{(n)}$

$$\int \phi(x_1, x_2, \ldots x_n; \theta_1, \ldots \theta_t; \theta_{t+1}, \ldots \theta_{t+s}) d(x^{(n)}) = \alpha \qquad ..(3{\cdot}5)$$

Among such regions again, we can find one $w^{(n)}$ which would depend upon $(\alpha; \theta^0_1, \ldots \theta^0_t; \theta^0_{t+1}, \ldots \theta^0_{t+s}; \theta_1, \ldots \theta_t; \theta_{t+1}, \ldots \theta_{t+s})$ being defined by

$$\phi(x_1, \ldots x_n; \theta_1, \ldots \theta_t; \theta_{t+1}, \ldots \theta_{t+s}) \geqslant \lambda \phi(x_1, \ldots x_n; \theta^\circ_1 \ldots \theta^\circ_t; \theta^\circ_{t+1}, \ldots \theta^\circ_{t+s}) \quad (3{\cdot}51)$$

where λ is chosen so as to satisfy (3.5)

The main questions in testing of composite hypothesis are :

(*i*) whether it is possible to get a $W^{(n)}$ satisfying (3.4) ,which would depend upon only $(x;\ \theta^0_{t+1},\ \ldots\theta^0_{t+s})$ no matter what $(\theta^0_1,\ \ldots\theta^0_t)$ might be. If so, how to generate such regions and tests based thereon,

(*ii*) if such regions are available at all whether it is possible to choose from amongst them a region which, while satisfying (3.51), should be such that its boundary should depend only on $(x\ ;\ \theta^0_{t+1},\ \ldots\theta^0_{t+s}\ ;\ \theta_{t+1},\ \ldots\theta_{t+s})$ and be free from $(\theta^0_1,\ \ldots\theta^0_t;\ \theta_1,\ \ldots\theta_t)$

Regions $W^{(n)}$ fulfilling the conditions posed under (*i*) are known as ***similar regions*** with regard to the total sample space. In this discussion we shall call them valid tests. Question(*ii*) then relates to the possibility of obtaining among these valid tests the most powerful test with regard to any alternative $(\theta^{(1)})$ both the hypothesis to be tested and the alternative kept in view being not specific but broad in the sense that in either of them the $(\theta_1,\ \theta_2,\ \ldots\theta_k)$ may take any set of values within the domain. The position of the 'likelihood ratio test' in the scheme of composite hypothesis may be here briefly touched upon. The 'likelihood ratio test' for the hypothesis $(\theta_i = \theta^0_i$ with $i = t+1,\ \ldots\ldots t+s)$; would be given by

$$\phi(x_1,\ldots\ldots x_n : \hat{\theta}^0_1,\ \ldots\ldots\hat{\theta}^0_t\ ;\ \theta_{t+1},\ldots\ldots\theta_{t+s}) \leqslant \mu\phi\ (x_1,\ldots,\ldots x_n\ ;\ \hat{\theta}_1,\ldots,\ldots\hat{\theta}_t\ ;\ \hat{\theta}_{t+1}, \ldots\hat{\theta}_{t+s}) \qquad \ldots\ (3.511)$$

where μ is so chosen as to satisfy (3.5), and where $\hat{\theta}^0_1$ etc. on the left hand side are the maximum likelihood solutions of θ_1, etc. on the assumption that $(\theta_i = \theta^0_i\ ;\ i = t+1,\ldots\ldots t+s)$ while the $(\hat{\theta}_1,\ \ldots\ldots\hat{\theta}_{t+s})$ on the right hand side of (3.511) are the solutions irrespective of any such assumptions. Apart from the limitation discussed under (3.3) this test here suffers from the further drawback that there is no knowing whether it would be a valid test at all. Whether solutions of problems posed under (*i*) and (*ii*) would be available at all would obviously depend upon the form of ϕ, and in trying to answer questions (*i*) and (*ii*) Neyman and Pearson found that a *sufficient set* of conditions for (*i*) being possible, would be :—

(*ia*) for $t = 1$, i.e. for one degree of freedom of the composite hypothesis in which the parameter is θ,

$$\frac{\partial^2 \log \phi}{\partial\theta^2} = A + B\frac{\partial}{\partial\theta} \log \phi \qquad \ldots(3\cdot52)$$

where A and B might involve the free parameter and the non-free parameters but must not involve $(x^{(n)})$

(*ib*) for any general t

$$\frac{\partial^2 \log \phi}{\partial\theta_i\,\partial\theta_j} = A_{ij} + \sum_{l=1}^{t} B^{(l)}_{ij}\ \frac{\partial \log \phi}{\partial\theta_l} \quad (i, j = 1,\ 2,\ldots t) \qquad .(3\cdot53)$$

where A_{ij}'s and $B^{(l)}_{ij}$'s might involve both the free and non-free parameters. Conditions (3.53) may not all be independent. Under (3.52) for $t = 1$ and under (3.53) for any general t, not only one but an infinity of valid tests of a certain type has been shown to exist and furthermore a method of generation of this

type of valid tests has also been given. This method of generation (for case (*ib*) of which (*ia*) would be a special case) is based upon the following pro perties (which exist under (3.52) and (3.53)) :—

(*ic*) there is a t-fold infinity of surfaces (of dimensions $n-t$) given by the interesection of

$$\frac{\partial}{\partial \theta_i} \log \phi = \lambda_i \quad (i=1, 2, \ldots t)$$

and represented by $S(\lambda_1, \lambda_2, \ldots \lambda_t)$ the location of which (as a family) in the sample space of n dimensions is invariant for all values of the free parameters $(\theta_1, \theta_2, \ldots \theta_t)$ but might depend upon the non-free parameters $(\theta_{t+1}, \ldots \theta_{t+s})$.

(*id*) if from any shell (between two neighbouring surfaces) we cut off a portion whose mass(as based on the probability density ϕ associated with the hypothetical values of the non-free parameters $(\theta^0_{t+1}, \ldots \theta^0_{t+s})$ and of the free parameters $(\theta^0_1, \ldots \theta^0_t)$) is $\alpha(<1)$ times the mass of the total shell and whose relative location within the shell might depend upon the hypothetical values of the non-free parameters $(\theta^0_{t+1}, \ldots \theta^0_{t+s})$ but could be arranged to be independent of the hypothetical values of the free parameters $(\theta^0_1, \ldots \theta^0_t)$, then the mass of such a portion would continue to be α times the mass of the the total shell for all hypothetical values of the free parameters $(\theta^0_1, \ldots \theta^0_t)$

Under (*ic*) and (*id*) we could evidently cut off such a portion of the shell in an infinity of ways. We can now generate at the level of significance $\alpha(<1)$ a valid test of $H(\theta_i = \theta^0_i)$ $(i=t+1, t+2, \ldots t+s)$ by cutting off from any shell such a portion and putting together such portions from the totality of different shells. This would give a critical region whose location in the sample space might depend on the hypothsis $(\theta^0_{t+1}, \ldots \theta^0_{t+s})$ but is independent of the *pseudo-hypothesis* $(\theta^0_1, \ldots \theta^0_t)$ while the mass is α times the total mass of the sample space, i.e. simply α for all values of the *pseudo-hypothesis*.

(*ie*) It was proved that under certain mild restrictions there could not be any other valid test except those generated by the mechanism. Remembering the freedom within each shell, such valid tests could evidently be generated in an infinite number of ways.

This mechanism of generation of valid tests is really deeper and of more far-reaching significance and greater generality than the differential equations (3.52) and (3.523). With regard to the *existence of valid tests* it was found later that the essential properties (*ic*), (*id*) and (*ie*) and the associated mechanism would be still available under somewhat wider conditions than (3.52) and (3.53), being given by

$$\left.\begin{array}{l} (if)\ \phi = \phi_1(T_1, T_2, \ldots T_m\,;\, \theta_1, \theta_2, \ldots \theta_t\,;\, \theta_{t+1}, \ldots \theta_{t+s})\, \phi_2(x_1, \ldots x_n\,;\, \theta_{t+1}, \ldots \theta_{t+s}) \\ \text{where} \\ T_i = F_i(x_1, \ldots x_n;\, \theta_{t+1} \ldots \theta_{t+s}) \quad (i=1, 2, \ldots m\,;\, m>, \text{ or } =, \text{ or } <t, \text{ but } <n) \end{array}\right\} \ldots (3.54)$$

In such a case $(T_1, T_2, \ldots T_m)$ might be said to be a shared sufficient set of statistics for $(\theta_1, \theta_2, \ldots \theta_t)$ conditional on $(\theta_{t+1}, \ldots \theta_{t+s})$ being known. If (3.54) holds we have a system of m-fold (and not t-fold) infinity of surfaces (of dimensions $n-m$) given by the interesection of

$$F_i(x_1, x_2, \ldots x_n\,;\, \theta_{t+1}, \ldots \theta_{t+s}) = \lambda_i \; (i=1, 2, \ldots m) \qquad \ldots (3.55)$$

which would fulfil the basic conditions of (1) *invariance of location* given by (*ic*), (2) *invariance of mass proportionality* given by (*id*), and under certain mild restrictions, (3) the *exhaustiveness with regard to valid tests.* Such a family of surfaces would thus provide the basic mechanism already considered for generation of valid tests of $H(\theta_i = \theta^0_i)$ $(i = t+1, \ldots t+s)$. With regard to the *availability, among these valid tests, of a most powerful test* of $H(\theta_i = \theta^0_i)$ with respect to the alternative $H(\theta_i \neq \theta^0_i)$ we note that if, furthermore, the T_i's referred to in (3.54) are of the form

$$T_i = F_i(x_1, x_2, \ldots x_n) \qquad ..(3.56)$$

then among the *valid tests* associated with the mechanism, the *unbiassed and most powerful test* of $H(\theta_i = \theta^0_i)$ with regard to the alternative $H(\theta_i \neq \theta^0_i)$ $(i = t+1, \ldots t+s)$ would be provided by the domain $w^{(n)}$ obtained by eliminating $(\lambda_1, \lambda_2, \ldots \lambda_m)$ between

$$F_i(x_1, \ldots x_n) = \lambda_i (i = 1, 2, \ldots m) \qquad ..(3.57)$$

and

$$\phi(x_1 \ldots x_n;\ \theta_1, \ldots \theta_t;\ \theta_{t+1}, \ldots \theta_{t+s}) \geqslant \lambda\phi(x_1, \ldots x_n;\ \theta^0_1, \ldots \theta^0_t;\ \theta^0_{t+1}, \ldots \theta^0_{t+s}) \qquad ..(3.58)$$

where λ is so chosen as to satisfy

$$\int\phi(x_1, \ldots x_n;\ \theta^0_1, \ldots \theta^0_t;\ \theta^0_{t+1} \ldots \theta^0_{t+s}) d(x^{(n)}) = \alpha \qquad ..(3.59)$$

the integration being taken over the shell defined by (3.57) and (3.58). λ thus is really of the from $\lambda\ (\alpha;\ \lambda_1, \ldots \lambda_m;\ \theta^0_{t+1}, \ldots \theta^0_{t+s};\ \theta_{t+1}, \ldots \theta_{t+s})$

It may be noted that so far as location and other properties of this domain are concerned the *pseudo-hypothesis* $(\theta_i = \theta^0_i)$ *and pseudo-alternative* $(\theta_i \neq \theta^0_i)$ $(i = 1, 2, \ldots t)$ go out of the picture altogether. We have thus a solution of the question posed under (*ii*).

For $m = 1$ and for the availability of the most powerful test among the set of valid tests, we have instead of the condition (3.56), either of the conditions :

$$\phi_2\ (x_1, \ldots x_n;\ \theta_{t+1}, \ldots \theta_{t+s}) = \phi_2\ (x_1, \ldots x_n) \qquad ..(3.591)$$

or

$$\phi_2(x_1, \ldots x_n;\ \theta_{t+1}, \ldots \theta_{t+s}) = \text{a function of } F(x_1, \ldots x_n, \theta_{t+1}, \ldots \theta_{t+s}) \qquad ..(3.592)$$

where F, for $m = 1$, and ϕ_2 occur on the right hand side of (3.54). We have thus (i) a set of sufficient conditions for the availability of valid tests of $H(\theta_i = \theta^0_i)$ and a particular mechanism for their generation, and (*ii*) a further set of sufficient conditions for the availability as among these valid tests of the most powerful test of the hypothesis with regard to the alternative $H\ (\theta_i \neq \theta_i^0)$ $(i = t+1, \ldots t+s)$, in either case no matter what $(\theta_1, \theta_2, \ldots \theta_t)$ might be.

We note further that while the of existence sufficient statistics in the sense of (1.2) is related to the availability of uniformly most powerful tests of a simple hypothesis, the existence of pseudo-sufficient statistics in the sense of (1·54) is related to the availability of valid tests of a composite hypothesis.

§ 4. Neyman's Theory of Confidence Intervals

Neyman's theory of broad (as distinct from specific) estimation, based as it is on his theory of testing of hypothesis, may be fruitfully taken up at this stage. Here again we can, for simplicity, but without vitally affecting the generality of the theory, consider the case of one parameter alone which,

let us call, θ. If, given a probability law, $\phi(x_1, \ldots x_n ; \theta)$ and a set of observations $(x^{(n)})$ to be called (E_n), two functions of (E_n), $\theta_1(E_n)$ and $\theta_2(E_n)(>\theta_1(E_n))$ could be found such that

$$P\{(\theta_1(E_n) \leqslant \theta \leqslant \theta_2(E_n))/\theta\} = \alpha \qquad \ldots(4)$$

for all (permissible) values of θ, then the interval associated with $\{\theta_1(E_n), \theta_2(E_n)\}$ to be called $\vartheta(E_n)$ is said to be a confidence interval for θ at the level α. The statement $\{\theta_1(E_n) \leqslant \theta \leqslant \theta_2(E_n)\}$ is often replaced by $\vartheta(E_n)$ covers θ, or in symbols, $\vartheta(E_n) \, C\theta$; the statement $P\{\theta_1(E_n) \leqslant \theta \leqslant \theta_2(E_n)/\theta\} = \alpha$ is also replaced by

$$P\{\vartheta(E_n) \; C\theta/\theta\} = \alpha \qquad \ldots(4.1)$$

It must be noted here that the probability statement in (4) does not mean probability of something happening to θ but probabiltity of something happening to the statistics or functions of the stochastic variables $(x_1, \ldots x_n)$, namely, $\theta_1(E_n)$ and $\theta_2(E_n)$, in relation to a non-stochastic θ, the probability remaining the same for all possible values of the non-stochastic θ. It is this that makes (4) partly similar to but in many respects quite dissimilar from inverse probability and Bayes' thorem. This technical sense in which (4) is to be taken, while it keeps the theory within the four corners of orthodox probability, partly robs it of that physical appeal which it would otherwise have had if (4) had been, which it is not, a probability statement in respect of θ. This theory and technique of estimation by confidence interval is related to Neyman and Pearson's theory of testing of hypothesis in the following way. We can here conveniently replace the critical region $W^{(n)}$ (for rejection of any hypothesis about θ) by the complementary region (of acceptance) and the level of significance α by the complementary quantity $1-\alpha$, while continuing to use the same symbols.

A region $W^{(n)}$ depending on θ and satisfying

$$P\{E_n \in W^{(n)} (\theta)/\theta\} = \alpha \text{ (for all } \theta) \qquad \ldots(4.2)$$

will, under certain mild restrictions involving, among other things, the one-way shift of the interval with change in θ, lead to a pair of $\theta_1(E_n)$, $\theta_2(E_n)$ or an interval $\vartheta(E_n)$ such that

$$P\{\vartheta(E_n) C \, \theta/\theta\} = \alpha \quad \text{(for all } \theta) \qquad \ldots(4.21)$$

The most powerful and unbiassed region $w^{(n)}(\theta_0, \theta)$ (of acceptance of θ_0) with regard to the alternative θ, depending, apart from x, on both θ_0 and θ is defined such that

$$\left.\begin{array}{l} \text{inside } w_0^{(n)}(\theta_0, \theta) : \phi\{(x^{(n)}) ; \theta\} \leqslant \lambda(\alpha, \theta_0, \theta) \phi\{(x^{(n)}); \theta_0\} \\ \text{where } \lambda \text{ is chosen so as to satisfy} \\ \qquad P\{E_n \in w_0^{(n)}(\theta_0, \theta)/\theta_0\} = \alpha \end{array}\right\} \qquad \ldots(4.3)$$

This, under the restrictions of (4.21) and some more restrictions, leads to an $\vartheta_0 (E_n ; \theta)$ (depending on θ but independent of θ_0) such that for all θ_0 but a particular θ

$$P\{\vartheta_0(E_n ; \theta) \, C \, \theta_0/\theta\} \leqslant P\{\vartheta(E_n) C \, \theta_0/\theta\} \text{ and } \leqslant P\{\vartheta_0(E_n ; \theta) C \, \theta_0/\theta_0\} \qquad \ldots(4.31)$$

where $\vartheta(E_n)$ is any interval satisfying (4.21). $\vartheta_0(E_n ; \theta)$, however, might have one form for $\theta_0 < \theta$ and another form for $\theta_0 > \theta$. Such an $\vartheta_0(E_n ; \theta)$ may

be called a shortest and unbiassed confidence interval for θ_0 with regard to the specific alternative θ. This, however, is an interval of purely academic interest and of no particular physical significance.

If, however, $w_0^{(n)}(\theta_0, \theta)$ of (4.3) depends only on θ_0 (apart from α) but is independent of θ or at any rate if it is of one form for all $\theta < \theta_0$ and another form for $\theta > \theta_0$ we have the uniformly most powerful and unbiassed test (or tests) for θ_0 with regard to all θ (or all $\theta < \theta_0$ and $\theta > \theta_0$ respectively), The associated $\vartheta_0(E_n)$ (which this time would be independent of θ or at any rate, have one form for $\theta < \theta_0$ and another for $\theta > \theta_0$) will now satisfy

$$P\{\vartheta_0(E_n)\, C\theta_0|\theta\} \leqslant P\{\vartheta(E_n)\, C\theta_0|\theta\} \text{ and} \leqslant P\{\vartheta_0(E_n)\, C\theta_0|\theta_0\} \text{ i.e.} \leqslant \alpha \quad ..(4.4)$$

where $\vartheta(E_n)$ is any interval satisfying (4.31).

Either (4.4) will be satisfied for all θ_0 and θ or there will be a $\vartheta'_0(E_n)$ satisfying (4.4) for all $\theta < \theta_0$ and an $\vartheta''_0(E_n)$ satisfying (4.4) for all $\theta > \theta_0$. $\vartheta_0(E_n)$ may be called a uniformly shortest and unbiassed confidence interval for θ_0, and $\vartheta_0'(E_n)$ and $\vartheta_0''(E_n)$ the two one-sided (but uniformly) shortest and and unbiassed confidence intervals for the ranges of alternatives $\theta < \theta_0$ and $\theta > \theta_0$.

It would be obvious that it is these intervals that are of real physical significance. This, therefore, being the only optimum of practical interest, and uniformly most powerful tests on which this is based being seldom available, the optimum confidence interval would also, thus, be seldom available. The partially optimum interval of (4.31) based on the partially optimum test of (4.3) (which is almost always available) is, as already observed, ruled out on physical grounds. Confidence intervals based on locally most powerful and locally unbiassed tests, and those corresponding to simple hypothesis with more than one parameter and those corresponding to composite hypothesis (which are of course physically very important) could be generated by processes already suggested and without any serious conceptual difficulties. These need not be taken up in the present discussion. There is an interesting theory of confidence intervals due to Prof. U. S. Nair in which more stress is laid on the physical length of the confidence interval, but lack of time would not permit a discussion of it here.

§ 5. Wald's Theory of Statistical Inference

A. Need and Genesis

The transition to Wald's theory of statistical inference may be conveniently considered at this stage. Taking the so-called parametric cases, suppose that in any situation a uniformly most powerful test (even in the limited sense already discussed) does not, as will often happen, exist. The uniformly shortest confidence interval (even in the restricted sense) will not also be there. We have of course the most powerful test with regard to a particular alternative and a corresponding confidence interval (which latter, however, is not of any physical interest); but it would be clear on a little reflection that while a most powerful test with regard to a particular alternative almost always exists and may not be also in practice difficult to construct, our physical interest consists in finding out not so much what a particular hypothesis or estimate is worth vis-a-vis another particular hypothesis or estimate but what it may be worth vis-a-vis the totality (or a suitable sub-totality) of other possible alternatives or estimates. To this last query a very good answer is of course provided by a uniformly most powerful test (when it exists) and the associated confidence interval.

But when it does not, we have naturally to look out for the next best thing in an overall sense (i.e. over all alternatives). In this situation, therefore, the questions naturally arise : (i) could we have in any sense a sort of optimum test (or interval) with regard to the different possible alternatives as a whole ? If so, in what sense and how ? (*ii*) Furthermore, could we have tests possessing in large samples some overall optimum properties which might be no longer there when the sample size gets smaller ?

B. Asymptotically Most Powerful Tests and Shortest Confidence Intervals

In attempting to answer query (*ii*), Wald was led on to develop his theory of asymptotically most powerful tests and asymptotically shortest confidence intervals. Without any essential loss of generality we shall consider the case of only one parameter θ, and of independent stochastic variables having the same probability law $f(x\ ;\ \theta)\ dx$.

In this case

$$\phi\ \{(x^{(n)})\ ;\ \theta\} = \prod_{i=1}^{n} f\ (x_i\ ;\ \theta) \qquad ..(5)$$

Adopting in part Wald's notation let us denote by $\{W^{(n)}(\alpha,\theta_0)\}$ the sequence of critical regions $W^{(n)}$ for $n=1,2,...$ ad inf, for testing the hypothesis $\theta=\theta_0$ at the level of significance α. This means, of course, that

$$P\{E_n \epsilon\ W^{(n)}\ (\alpha\ ;\ \theta_0)/\theta_0\} = \alpha \text{ for all } n,\ \alpha \text{ and } \theta_0 \qquad ..(5.1)$$

Consider another sequence of regions $\{w^{(n)}\ (\alpha\ ;\ \theta_0\}$ satisfying (5.1).

Denote by $L[W^{(n)}\ (\alpha\ ;\ \theta_0),\ w^{(n)}\ (\alpha;\theta_0)]$ the least upper bound of

$$P\{E_n\epsilon W^{(n)}\ (\alpha\ ;\ \theta_0)/\theta\}-P\{E_n\epsilon w^{(n)}\ (\alpha\ ;\ \theta_0)/\theta\} \qquad ..(5.11)$$

with regard to all possible values of θ.

Denote also by $g[W^{(n)}\ (\alpha\ ;\ \theta_0)]$ the greatest lower bound (for variation of θ) of

$$P\{E_n\epsilon W^{(n)}\ (\alpha\ ;\ \theta_0)/\theta\} \qquad ..(5.12)$$

(a) Then $\{w^{(n)}\ (\alpha\ ;\ \theta_0)$ is said to be an asymptotically most powerful test of $\theta=\theta_0$ at the level α, (*i*) if it satisfies (5.1), and (*ii*) if for any other sequence $\{W^{(n)}\ (\alpha\ ;\ \theta_0)\}$ satisfying (5.1) we have

$$\underset{n\to\infty}{\text{Limit Superior}}\ L[W^{(n)}\ (\alpha\ ;\ \theta_0),\ w^{(n)}\ (\alpha\ ;\ \theta_0)]\leqslant 0 \qquad ..(5.2)$$

(b) Also $\{w^{(n)}\ (\alpha\ ;\ \theta_0)\}$ is said to be an asymptotically most powerful unbiassed test of $\theta=\theta_0$ at the level α, (*i*) if it satisfies (5.1), (*ii*) if furthermore $\lim\limits_{n\to\infty} g\ [w^{(n)}\ (\alpha\ ;\ \theta_0)]=\alpha$, and lastly (*iii*) if in any relation to any sequence $\{W^{(n)}\ (\alpha\ ;\ \theta_0)\}$ satisfying (*i*) and (*ii*), the sequence $\{w^{(n)}\ (\alpha\ ;\ \theta_0)\}$ satisfies (5.2).

If instead of considering any general $W^{(n)}\ (\alpha\ ;\ \theta_0)$ satisfying (5.1) we consider $w^{(n)}\ (\alpha\ ;\ \theta_0,\ \theta)$ which gives the most powerful and unbiassed test of $\theta=\theta_0$ with regard to $\theta\neq\theta_0$ then obviously for any $W^{(n)}\ (\alpha\ ;\ \theta_0)$ satisfying (5.1)

$$P\{E_n\epsilon w^{(n)}\ (\alpha\ ;\ \theta_0,\ \theta)/\theta\}-P\{E_n\epsilon W^{(n)}\ (\alpha\ ;\ \theta_0)/\theta\}\geqslant 0 \qquad ..(5.3)$$

Let the least upper bound of this (for different values of θ) be denoted by

$$L\,[w_0^{(n)}\,(\alpha\,;\,\theta_0),\ W^{(n)}\,(\alpha\,;\,\theta_0)] \qquad ..(5.31)$$

(A) It would be clear now on comparison of (5.2) with (5.3) that an asymptotically most powerful test of $\theta=\theta_0$ at level α, namely, $\{w^{(n)}\,(\alpha\,;\,\theta_0)\}$ will (*i*) satisfy (5.1) and (*ii*) will also satisfy

$$\underset{n\to\infty}{Lt}\ L[w_0^{(n)}\,(\alpha\,;\,\theta_0),\ w^{(n)}\,(\alpha\,;\,\theta_0)] = 0 \qquad ..(5.4)$$

(B) It would also be clear on a similar comparison that an asymptotically most powerful unbiassed test will, besides satisfying the condition given in (A), satisfy the further condition that $\underset{n\to\infty}{Lt}\ g\,[w^{(n)}\,(\alpha\,;\,\theta_0)] = \alpha$.

Condition (5.2) together with (5.4) would immediately show that as the sample size n increases the power of the test $w^{(n)}\,(\alpha\,;\,\theta_0)$ for each alternative $\theta \neq \theta_0$ approaches the power of the most powerful test for that alternative. This brings out the appropriateness of the term 'asymptotic'.

We have, of course, the asymptotically shortest confidence interval associated with (b). Conceptually these would not offer new difficulties but in some of the details certain special considerations come in which, however, need not be discussed, and these confidence intervals need not be dealt with separately here.

Now $\{w^{(n)}\,(\alpha\,;\,\theta_0)\}$ satisfying either (A) or (B) may not exist at all or more than one also might exist. It has been shown that under certain not stringent restrictions on the form of the parent population the regions (*i*) $w'^{(n)}\,(\alpha\,;\,\theta_0)$ defined by $\sqrt{n}\,(\hat{\theta}-\theta_0) \geqslant c'_n$, (*ii*) $w''^{(n)}\,(\alpha\,;\,\theta_0)$ defined by $\sqrt{n}\,(\hat{\theta}_n - \theta_0) \leqslant c''_n$ and (*iii*) $w'''^{(n)}\,(\alpha\,;\,\theta_0)$ defined such that at least one of the inequalities are satisfied: $\sqrt{n}\,(\hat{\theta}_n-\theta_0) \geqslant c'''_n$ or $\leqslant -c'''_n$, would be respectively (*i*) the asymptotically most powerful test for alternatives $\theta > \theta_0$, (*ii*) the asymptotically most powerful test for alternatives $\theta < \theta_0$, and (*iii*) the asymptotically most powerful unbiassed test for all real θ.

It has been also shown that under fairly mild restrictions there might be other asymptotically most powerful tests as well, and methods of construction of such tests have also been given. This, therefore, is the counterpart (in testing of hypothesis) of the large sample theory of efficiency in Fisher's theory of estimation. The question now arises as to how to choose from amongst different asymptotically most powerful tests if more than one exist, as would happen under fairly mild restrictions. The choice is to be made on the principle that that $\{w^{(n)}\,(\alpha\,;\,\theta_0)\}$ would be said to be optimum for which the rapidity of convergence to the limit indicated in (4.5) would be the greatest. It is generally believed and partly proved that the regions w', w'', w''' already indicated, while not possessing these optimum properties, would in most cases come fairly close to optimum. There is, as has been already observed, a similar development for 'asymptotically' shortest confidence intervals which we shall not discuss here.

C. Most Powerful Tests on an Average

We turn now to the problem (*i*) posed in (A) of this section which is really the small sample theory of overall optimum tests in cases where uniformly most powerful tests even in a limited sense are lacking. As observed earlier, here again we shall take up in the first place the para-

metric case under which we shall consider for simplicity but without any essential loss of generality the case of a simple hypothesis about k parameters $\theta_1,\theta_2,\ldots\theta_k$ to be sometimes called $(\theta^{(k)})$; with this may be conveniently associated a parametric space Ω. For purposes of testing any hypothesis $H(\theta_i=\theta^0_i)$ $(i=1,2,\ldots k)$ the essence of this theory consists in trying to find out the most powerful test on an average with regard to all permissible alternatives, the averaging being over the parametric space Ω and based on a suitable system of weightage. This suitable system naturally takes into account the relative importance of different deviations from the hypothesis, i.e. of $(\theta_i-\theta^0_i)$ $(i=1,2,\ldots k)$, the relative importance itself being related to extra-statistical or extra-mathematical considerations. Let us have a weightage function $h(\theta_1-\theta^0_1,\ldots\theta_k-\theta^0_k)$ which is zero when $\theta_i=\theta^0_i$ $(i=1,2,\ldots k)$ and which satisfies

$$\int_\Omega h\ (\theta_1-\theta_1^0,\ldots\ \theta_k-\theta^0_k)\ \prod_{i=1}^{k} d\theta_i=1 \qquad ..(5.5)$$

where the integration is over the whole parametric space Ω.
Let also

$$\int_\Omega h\ (\theta_1-\theta^0_1,\ldots\theta_k-\theta^0_k)\ \phi(x_1,\ldots x_n\ ;\ \theta_1,\ldots\theta_k)\ \prod_{i=1}^{k} d\theta_i = \phi_h(x_1,\ldots x_n\ ;\ \theta^0_1,\ldots\theta^0_k) \quad (5.51)$$

Then evidently a region $w^{(n)}_h$ in the sample space defined such that inside

$$w^{(n)}_h: \phi_h(x_1,\ldots x_n\ ;\ \theta^0_1,\ldots\theta^0_k)\geqslant\lambda\ \phi\ (x_1,\ldots x_n\ ;\ \theta^0_1,\ldots\theta^0_k) \qquad ..(5.52)$$

where λ is so chosen as to satisfy

$$\int_{w^{(n)}_h} \phi\ (x_1,\ldots x_n\ ;\ \theta^0_1,\ldots\theta^0_k)\ d\ (x^{(n)})=\alpha \qquad ..(5.53)$$

will possess the property that

$$\int_{w^{(n)}_h} \phi_h\ (x_1,\ldots x_n\ ;\ \theta^0_1,\ldots\theta^0_k)\ d\ (x^{(n)})\geqslant \int_{W^{(n)}} \phi_h\ (x_1,\ldots x_n\ ;\ \theta^0_1,\ldots\theta_k)d(x^{(n)}) \quad ..(5.54)$$

where $W^{(n)}$ is any region (in the sample space) satisfying (5.53).

A critical region $w^{(n)}_h$ satisfying (5.52) and (5.53) will be said to be the most powerful test of H $(\theta_i=\theta^0_i)(i=1,\ 2,\ldots k)$ on an average (over all alternatives), the average being related to the weight function h.

The analysis above would evidently be permissible under certain mild restrictions on the form of ϕ vis-a-vis the stochastic variables $(x_1,\ x_2,\ldots x_n)$ and the non-stochastic parameters $(\theta_1,\ldots\theta_k)$, including the assumption that the operations of integration over $(x_1,\ldots\ x_n)$ and $(\theta_1,\ \ldots\ \theta_k)$ could be interchanged. But the basic concepts involved are more general than the particular type of analysis employed. So far as one can see to-day the weight function h could be based on either of three considerations : (*i*) any *a priori* grounds of belief in the different alternatives $(\theta_1,\ \ldots\ \theta_k)$, or (*ii*) any physical measure in terms of loss sustained or difference otherwise made when the the true hypothesis is (θ_i's) instead of (θ^0_i's) $(i=1,\ 2,\ldots k)$, or (*iii*) something like a distance function between two statistical populations, constructed in terms of pure elementary frequencies and possessing a number of elegant mathematical properties. The first type of consideration, besides being practically inconsequential, is not also free from theoretical objections. The second type is physically most important and useful, while the third

related as it is to pure probability, has a good deal of mathematical and theoretical elegance. So far we have kept to simple hypothesis concerning the parameters ($\theta_1, \ldots \theta_k$). If in this case we change over to composite hypothesis, the set-up given here will merely have to be superposed on the set-up for composite hypothesis already discussed, without in any way replacing it. It has been noted that some of the usual tests (in situations where uniformly most powerful tests do not exist), as for instance the 'F' test in the general scheme of analysis of variance, possess the optimum property of being most powerful on an average in terms of rational weight functions based on considerations like either (*ii*) or (*iii*). We shall not discuss the details of this any further here.

D. Wald's General and Unified Theory Statistical Inference

We are now in a position to pass on to Wald's general theory of statistical inference which, as already observed in the introduction, besides broadening the basis of both estimation and testing of hypothesis, fuses both into a remarkable synthesis. Without any essential loss of generality the outlines of this theory (so far as an indication of its general nature is concerned) can be presented in terms of a parametric case with k parameters ($\theta_1, \ldots \theta_k$)and an associated parametric space or domain Ω, the form ϕ of probablity density for ($x_1, \ldots x_n$) being supposed to be known. Suppose that the parametric space Ω is split up into a system of disjoin , i.e. non-overlapping regions Θ in a manner given once for all in a particulat physical situation ,and suppose that on the basis of any arbitrary rule (which we could vary) we set up disjoint regions w_Θ in the sample space such what whenever

$E_n \in w_\Theta$ we accept the hypothesis H_Θ that the parametrite set $(\theta^{(k)})$ lies

in Θ. These Θ's are not usually points but regions of the parametric space Ω. Furthermore, $\Sigma_\Theta\, w_\Theta$ = the whole of the sample space. By inversion we can,

uniquely for our rule, associate with any point E_n of the sample space a region $\Theta(E_n)$ of the parametric space Ω, which coincides with one or other of the different Θ's. This means that given any E_n we should by our rule accept one or other of the different Θ's, which one of them to accept being related to the particular rule we set up. This function $\Theta(E_n)$ is known as a decision function. A different decision function $\Theta'(E_n)$ would imply a different rule on which, given the same E_n, we may be accepting a different region Θ' of the parametric space. There is a weight (or rather loss) function $h\{(\theta^{(k)}),\Theta\}$ such that $h = 0$ or ≤ 0 according as $(\theta^{(k)})$ belongs or does not belong to Θ. This h function is to be given by extra-statistical considerations and might conveniently be taken so as to satisfy a relation like (6.1) already considered. By our rule, therefore, for a true $(\theta^{(k)})$ the total likely loss (to be termed the risk r) as based on all possible E_n would be given by

$$\int h\{(\theta^{(k)}),\ \Theta(x^{(n)})\}\ \phi\{(x^{(n)})\ ;\ (\theta^{(k)})\}\ d\ (x^{(n)}) = r[(\theta^{(k)})/(\Theta,\ h)] \quad ..(5.6)$$

the integration being over the whole sample space.
The function r on the right hand side of (5.6) is really a function of $(\theta^{(k)})$, but the form of the function depends upon the forms of the decision function $\Theta(E_n)$ and the weight (or loss) function $h\{(\theta^{(k)}),\Theta\}$. This dependence is expressed by the symbolism on the right hand side of (5.6). Given a split-up into Θ's and a h function,the statistical problem now isto choose that decision function $\Theta(x^{(n)})$ which would minimise in some sense or other the risk given by (5.6) and would thus be an optimum in that sense. There might be different

rational senses and the broad development in terms of one of these is given as follows :—

(*i*) Two decision functions $\Theta\,(E_n)$ and $\Theta'\,(E_n)$ will be said to be equivalent if for each $(\theta^{(k)})$

$$r[(\theta^{(k)})/(\Theta,h)] = r[(\theta^{(k)})/(\Theta',\,h)] \qquad ..(5.7)$$

(*ii*) $\Theta(E_n)$ is said to be uniformly better than $\Theta'(E_n)$ if for all $(\theta^{(k)})$

$$r\,[(\theta^{(k)})/(\Theta,\;h)] \leq r[(\theta^{(k)})\;/\;(\Theta',h)] \qquad ..(5.8)$$

(*iii*) $\Theta(E_n)$ is said to be uniformly best if it satisfies (5.8) in relation to any $\Theta'\,(E_n)$

(*iv*) $\Theta(E_n)$ is said to be an admissible rule if there is no $\Theta'(E_n)$ uniformly better than this.

As between any two $\Theta(E_n)$ and $\Theta'(E_n)$, neither of (5.7) or (5.8) may hold. A test $\Theta(E_n)$ conforming to (*iii*) may not be available, and, in general, more than one $\Theta(E_n)$ conforming to (*iv*) would be available. In such a situation a further principle for choice of an optimum has to be looked for. The one that has been found to be physically most fruitful and theoretically least open to controversy seeks to so choose the decision function $\Theta(E_n)$ as to minimise the least upper bound of $r\,[(\theta^{(k)})/(\Theta,h)]$ with regard to variation of $(\theta^{(k)})$. For any given forms of h and Θ this least upper bound may be denoted simply by $r(\Theta,\;h)$, so that $\Theta^*(E_n)$ will be the optimum rule if $r(\Theta,h)$ becomes a minimum for $\Theta=\Theta^*$ Under certain not very stringent restrictions on the form of the weight function h and on that of the probability density function ϕ, this decision function $\Theta^*(E_n)$ possesses, among other elegant properties, the remarkable property that it makes $r[(\theta^{(k)})/(\Theta,\;h)]$ given by (5.6) independent of $(\theta^{(k)})$, i.e. it makes the risk function constant over the different alternatives. For lack of time and space we shall not discuss the various interesting and detailed developments of this theory including the extensions to the non-parametric cases that have occurred within the last four years.

It will be seen on a little reflection that (i) the problem of estimation covering both form and parameters, and in the parametric case, covering both point estimation and estimation by interval, and (*ii*) the problem of testing of hypothesis covering both form and the parameters, and in the parametric case, covering both simple and composite hypotheses are but special and degenerate cases of this generalised theory. But the problem posed under testing of composite hypothesis, which we have already discussed, are not rendered redundant by this theory but merely fit into a proper corner within the general set-up. With regard to form, however, by its very nature, the problem of choice can be successfully tackled only when the different possibilities are restricted to any concrete domain. Widest freedom here could only lead to an ethereal pseudo-generality. This set-up of Wald we have just discussed, while reaching out on the one hand to an adequate philosophical generalisation, keeps on the other hand fairly close to reality and concreteness (in fact gets closer to them than the earlier theories) through the mechanism of the risk function.

§ 6. Wald's Technique of Sequential Analysis

We take up last of all the technique of sequential analysis, already mentioned in the introduction, which has been a remarkable recent development spread over the last few years and due to Wald and his school. As noted earlier, the observations constituting a sample here are taken one after

another and the sample size under this technique, unlike that under the other techniques, is not preassigned but is in a sense a stochastic variable, whether the next observation is to be taken or not being dependent on what the observations taken so far have revealed.

Without any essential loss of generality an outline of the technique can be given in the case of a univariate and uniparametric population whose distribution law, for discrete x, may be taken as $f(x ; \theta)$, and, for continuous x, may be taken as $f(x ; \theta)dx$, where the form of the population f is assumed to be known, while θ, which is unknown, is supposed to be the main concern of the analysis. The technique is supposed to be so designed as to enable us to decide, after *a suitable or adequate number of observations*, between two contrary courses of practical action to be called actions 1 and 2. A concrete illustration of actions 1 and 2 might be acceptance or rejection of a batch of manufactured articles on the basis of a sample inspection. As a matter of fact it is this sort of situation that actually posed the general type of problem for which the technique of sequential analysis had to be designed. Pursuing this concrete illustration of manufactured articles, suppose we lay down a rule that if the sample of first ten articles inspected are found to be all non-defective we would accept the whole lot, and if, starting from the first, the *m th.* article ($m \leq 10$) is found to be defective we reject the whole lot. This means that in our inspection process, if the first article inspected is found to be defective we reject the lot, if it is non-defective we make a further inspection, and so on. By this rule laid down the process must necessarily terminate at the 10th observation; it might, however, terminate earlier. Passing on to the general problem, practical considerations (which would lay down different specifications in different situations) would usually specify a range $\theta_1 - \theta_2$ such that if $\theta \leq \theta_1$ we would not merely prefer action 1 to action 2 but it would make a material difference to us if we took action 2 instead of action 1, both the preference and the difference increasing as θ decreases, and likewise if $\theta \geq \theta_2$ we would not merely prefer action 2 to action 1 but it would make a material difference if action 1 was taken in place of action 2, here again both the preference and the difference increasing with increasing values of θ. The sampling rule (which, subject to certain broad conditions, might be otherwise arbitrary) should, therefore, be such that if we followed that rule then (*i*) the chance when $\theta \leq \theta_1$ of taking action 2 (which is undesirable) should be small and $\leq$ a preassigned α, and (*ii*) the chance when $\theta \geq \theta_2$ of taking action 1 (which is undesirable) should be small and $\leq$ a preassigned β. Furthermore, in the first case this chance should preferably (*ia*) decrease with decreasing θ and (*ib*) be equal to α when $\theta = \theta_1$; similarly in the second case this chance should preferably (*iia*) decrease with increasing θ and (*iib*) be equal to β when $\theta = \theta_2$. Under the rule the number n of observations to be taken as already noted is a stochastic variable determined in any particular sequence by the outcome of the observations themselves; (*iii*) but the rule should be so framed that with a finite n we can definitely decide between the two courses of action, i.e. the probability of having to take an indefinitely large n before we could reach a decision either way should be negligible. The 'chance' we have mentioned under, (*i*), (*ii*), (*ia*), (*iia*) etc. calls for a little explanation. There are two alternative courses to which our sampling procedure necessarily leads, namely, actions 1 and 2. For any θ, the 'chance' by our rule of taking action 1 would be based upon the totality of all $(x_1, x_2 \ldots x_n)$ with n itself being stochastic, such that any member $(x_1, x_2 \ldots x_n)$ of the totality would permit of action 1 being taken. This 'chance' therefore, would be a pure function of θ to be denoted by $L(\theta)$. This $L(\theta)$ plotted against θ is said to be an 'operating

characteristic curve' or simply OC curve. The conditions mentioned under (*i*), (*ii*), etc. can now be translated successively as

$$(i) \quad 1-\mathrm{L}(\theta) \leqslant \alpha \; (\theta \leqslant \theta_1) \qquad ..(6.1)$$

$$(ia) \quad 1-\mathrm{L}(\theta) = \alpha (\theta = \theta_1) \qquad ..(6{\cdot}11)$$

(*ib*) $1-\mathrm{L}(\theta)$ decreases as θ decreases in the domain $\theta < \theta_1$ ..(6.12)

$$(ii) \quad \mathrm{L}(\theta) \leqslant \beta \; (\theta \geqslant \theta_2) \qquad ..(6.2)$$

$$(iia) \quad \mathrm{L}(\theta) = \beta (\theta = \theta_2) \qquad ..(6.21)$$

(*iib*) $\mathrm{L}(\theta)$ decreases as θ inreases in the demain$\theta > \theta_2$ ..(6.22)

Among different sampling rules, all subject broadly to these conditions, a further criterion for choice of an optimum may be taken to be the average number of observations (which is related to the expense) needed under the rule, that rule naturally being the best for which this number would be the smallest. But this average, depending as it does on θ and hence denoted by $\mathrm{E}_\theta(n)$ varies with θ. This $\mathrm{E}_\theta(n)$ plotted against θ is known as the 'Average Sampling Number Curve' or simply the ASN curve. Suppose a rule could be found such that for all θ

$\mathrm{E}_\theta(n)$ under that rule $\leqslant$ $\mathrm{E}_\theta(n)$ under any other rule ..(6.3)

Then such a rule (which might be called a uniformly best rule) would naturally have been the optimum. But this being seldom available, various alternative criteria for the choice of a next best could be offered, of which one plausible and reasonable criterion might be that the optimum rule must be such that under it both for $\theta = \theta_1$ and $\theta = \theta_2$, $\mathrm{E}_\theta(n)$ should be a minimum as compared to what it would be under any other rule. It has been found that under certain broad assumptions this condition broadly ensures that $\mathrm{E}_\theta(n)$ under the rule would be less than $\mathrm{E}_\theta(n)$ under any other rule over a reasonable neighbourhood of θ_1 and θ_2 in the respective ranges $\theta < \theta_1$ or $\theta > \theta_2$ in a sense which need not be further discussed here. The optimum rule, therefore, might be one which, while satisfying conditions (6.1–6.22), would further minimise $\mathrm{E}_\theta(n)$ at $\theta = \theta_1$ and $\theta = \theta_2$, as just indicated. Under certain broad assumptions such optimum properties happen to be satisfied by a test based on what is called the sequential probability ratio sampling plan. The rule is indicated as follows :—

Denoting the successive observations by $(x_1, x_2, \ldots x_n)$ the probability density of a sequence of m observations $(x_1, x_2, \ldots x_m)$ for any given θ may be denoted by $\phi_m(\theta)$ where

$$\phi_m(\theta) = \prod_{i=1}^{m} f(x_i \; ; \; \theta) \qquad ..(6.4)$$

whence we can easily write $\phi_m(\theta_1)$ and $\phi_m(\theta_2)$.

The central idea behind the rule is that starting from the first observation we go on taking observations and at each stage calculating $\phi_m(\theta_2)/\phi_m(\theta_1)$ until it is either fairly small in which case we stop and decide on action 1, or it is fairly large in which case we stop and decide on action 2. This in symbols would mean that with two preassigned A and B,

(*i*) we decide on 1 if $\phi_m(\theta_2)/\phi_m(\theta_1) \leqslant \mathrm{B}$ ..(6.41)

(*ii*) we decide on 2 if $\phi_m(\theta_2)/\phi_m(\theta_1) \geqslant \mathrm{A}$ ..(6.42)

(*iii*) we repeat observations if $\mathrm{B} < \phi_m(\theta_2)/\phi_m(\theta_1) < \mathrm{A}$ ..(6·43)

where A and B are so chosen that $L(\theta)$ satisfies (6.11) and (6.21), i.e.

$$L(\theta_1) = 1-\alpha \quad \text{and} \quad L(\theta_2) = \beta \qquad ..(6.44)$$

It has been shown that A and B satisfy the conditions

$$A < \frac{1-\beta}{\alpha} \quad \text{and} \quad B > \frac{\beta}{1-\alpha} \qquad ..(6{\cdot}45)$$

In fact,

$$A \sim (1-\beta)/\alpha \text{ and } B \sim \beta/(1-\alpha) \qquad ..(6.46)$$

This $L(\theta)$ of course satisfies (6.11) and (6.21) and for most forms f would also satisfy (6.12) and (6.22). The form of this $L(\theta)$ is given by

$$L(\theta) \sim \frac{A^{h(\theta)}-1}{A^{h(\theta)}-B^{h(\theta)}} \qquad ..(6.5)$$

where A and B have been already given by (6.46) and $h(\theta)$ (usually unique under certain mild restrictions on f) is given by

$$\int f(x,\theta)\left[\frac{f(x,\theta_2)}{f(x,\theta_1)}\right]^{h(\theta)} dx = 1 \qquad ..(6.51)$$

The average sampling number $E_\theta(n)$ under this rule is given by the formula

$$E_\theta(n) \sim \frac{L(\theta)\log B + (1-L(\theta))\log A}{E_\theta[\log\{\phi_m(\theta_2)/\phi_m(\theta_1)\}]} \qquad ..(6.6)$$

when A, B and $L(\theta)$ have been already defined in terms of the presassigned quantities (α, β, θ_1, θ_2) and the variable parameter θ.

The most remarkable results, however, are that for any sampling rule satisfying (6.1) and (6.2)

$$E_{\theta_1}(n) \geq \left[(1-\alpha)\log\frac{\beta}{1-\alpha} + \alpha\log\frac{1-\beta}{\alpha}\right] \Big/ E_{\theta_1}[\log\{\phi_m(\theta_2)/\phi_m(\theta_1)\}] \qquad ..(6.71)$$

and

$$E_{\theta_2}(n) \geq \left[\beta\log\frac{\beta}{1-\alpha} + (1-\beta)\log\frac{1-\beta}{\alpha}\right] \Big/ E_{\theta_2}[\log\{\phi_m(\theta_2)/\phi_m(\theta_1)\}]. \qquad (6.72)$$

while for the sequential probability ratio sampling plan just discussed we have

$E_{\theta_1}(n) \sim$ right hand side of (6.71)

and $E_{\theta_2}(n) \sim$ right hand side of (6.72)

This gives the optimum property of this rule with regard to minimisation of $E_{\theta_1}(n)$ and $E_{\theta_2}(n)$.

Lack of space and time would not permit us to consider the various interesting and fruitful developments of this theory within the last three years including the use of sequential analysis in estimation by intervals or in certain other types of problems in testing of hypotheses.

With regard to sequential analysis there is one important point worth carefully noting. It is not a generalisation of the previous theories in the sense in which, say, Wald's theory of statistical inference is a generalisation of the older techniques. It is an alternative approach to a class of problems which the older theories also could, after some adjustments, tackle but in a less efficient manner, i.e. with a larger (but fixed) number than the average sampling number required by the optimum sample rule of the sequential type. But this is merely for certain classes of problems to which both would be applicable. It appears that there might be other classes of problems to which the older theories would apply but to which the sequential technique would not perhaps be relevant.

Concluding Remarks

From the rough sketch attempted above, certain side developments, quite important in themselves and already mentioned in their proper places, have had to be excluded, partly, as indicated earlier, for lack of time and space, and partly also because they do not quite fit in with the scheme of presentation followed here. To a similar reason is due the exclusion of techniques of multivariate analysis which Fisher, Hotelling and a few other distinguished men have enriched by their significant contributions and at which numerous common statistical workers all over the world including the present speaker have also laboured in their humble way over years.

But even under the limitations imposed by the particular objective and scheme of presentation, the sketch, as the speaker himself is well aware, is far from adequate ; it will nevertheless have served its purpose if it gave some glimpse, however partial and inadequate, of the imposing edifice, notable alike for its structural elegance and practical utility, of which the main architects have been Fisher, Neyman and Wald, but to the building of which have gone forth the labours of so many workers scattered far and wide.

Bibliography

A bibliography is given below which is far from exhaustive, being merely a list of the minimum number of papers (all not necessarily of the same importance) which the speaker has found necessary for purposes of this presentation.

Fisher's theory of estimation.

1. Doob, J.L. Statistical estimation, Trans. Amer. Math. Soc., Vol.39, pp. 410-421.

2. Fisher, R.A. On the mathematical foundations of theoretical statistics, Phil. Trans. of Royal Soc., Series A, Vol., 222, pp. 309-368.

3. Fisher, R.A. The theory of statistical estimation, Proc. Camb. Phil. Soc., Vol. 222, pp. 700-725.

4. Hotelling, H. The consistency and ultimate distribution of optimum statistics, Trans. Amer. Math. Soc., Vol. 32, pp. 847-859.

The general theory of testing of hypotheses.

5. Neyman, J. and Pearson, E.S. Contributions to the theory of testing of statistical hypotheses, Statistical Research Memoirs, Vol. 1, pp. 1-37.

6. Neyman, J. and Pearson, E. S. Sufficient statistics and uniformly most powerful tests of statistical hypotheses, Statistical Research Memoirs, Vol. 1, pp. 113-137.

7. Neyman, J. and Pearson, E. S. Contributions to the theory of testing of statistical hypotheses, Statistical Research Memoirs, Vol. 2, pp. 25-57.

The theory of testing of composite hypotheses.

8. Neyman, J. and Pearson, E.S. On the problem of the most efficient tests of statistical hypotheses, Phil. Trans. of Royal Soc., Series A, Vol. 231, pp. 289-337.

9. Neyman, J. On a statistical problem arising in routine analysis and in sampling inspections of mass production, Annals of Math. Stat., Vol. 12, pp. 46-76.

10. Roy, S. N. Notes on testing of composite hypotheses, Sankhyā, Vol. 8, pp. 257-270.

The theory of confidence intervals.

11. Neyman, J. Outline of a theory of statistical estimation based on the classical theory of probability, Phil. Trans. of Royal Soc., Series A, Vol.236, pp. 333-380.

Asymptotically most powerful tests and asymptotically shortest confidence intervals.

12. Wald, A. Asymptotically most powerful tests of statistical hypotheses, Annals of Math. Stat., Vol. 12, pp. 1-19.

13. Wald, A. Asymptotically shortest confidence intervals, Annals of Math. Stat., Vol. 13, pp. 127-137.

Distance function.

14. Bhattacharyya, A. On a measure of divergence between two statistical populations defined by their probability distributions, Bul. Cal. Math. Soc., Vol. 35. pp. 99-109.

Unified theory of statistical inference.

15. Wald, A. Contribution to the theory of statistical estimation and testing of hypotheses, Annals of Math. Stat., Vol. 12. pp. 299-326.

16. Wald, A. On the principles of statistical inference, Notre Dame mathematical lectures, No. 1.

Sequential Analysis.

17. Wald, A. Sequential Analysis, New York. John Wiley & Sons. 1947.

SECTION OF PSYCHOLOGY AND EDUCATIONAL SCIENCE

PRESIDENT: DR. ZAKIR HUSAIN, M.A., Ph.D.

PRINCIPLES OF EDUCATIONAL RECONSTRUCTION

FRIENDS,

I thank you cordially for the honour you have done me by asking me to preside at the Psychology and Educational Science Section of the Indian Science Congress. I wish I deserved the honour; I suspect I do not. But you have called me, so here I am. I am not a professional psychologist and have devoted the best years of my life to educational work. You will bear with me, I hope if I place before you at this meeting some thoughts about educational reconstruction in our country.

After a long night of bondage the Indian people are face to face with the dawn of freedom. In spite of the enormous difficulties of the very first days of its existence, our great social democracy is already engaged in hammering into shape a pattern of just honest and graceful living together which will make it, we trust, loved and respected by all men of goodwill. Indian education has a historic mission to perform in initiating and sustaining this fascinating pattern of civilized life. It should, therefore, be a matter of great concern to all of us as to how Indian education grows and develops. There is, as you know, no dearth of suggestions and proposals and schemes for educational expansion, reconstruction and reform. Actuated by a real or expected social or economic change, an act of thoughtless intellectual imitation or a deeply-rooted. Weltanschauung, by an exaggerated conviction or just a fleeting fashion, the variety of these educational proposals is simply bewildering. But a careful student will miss one thing in most, perhaps all, of them. There is seldom an attempt to give to these proposals of educational re-organization a scientific educational basis. Any field of non-scientific guess is the dilettante's paradise. Most of our educational thinking, I am afraid, is done in the unchartered freedom of such a paradise! We may well deliberately restrict this wayward freedom and try to relate our schemes of educational reform and reconstruction to a clear understanding of the educational process which alone, I think, can supply a scientific foundation for them. What, then, is the nature of this educational process? How is the culture of the mind possible? This process of mental culture or education shows a striking resemblance to the process of the growing development of the human body. As the body, from its embryonic beginnings, grows and develops to its full stature by means of suitable and assimilable food, movement and exercise, in accordance with physical and chemical laws, so does the mind grow and develop from its original dispositions to its full evolutionary cultivation by means of mental food and mental exercise according to the laws of mental growth. This mental food is supplied to the mind by the cultural goods of the society in which the mind is placed: its science, its art, its technique, its religion, its customs, its moral and legal codes, its social forms, its personalities. These material and moral goods of culture are, all of them, the product of the mental efforts of some individual or group. They are products or images signifying the meaning their originators wished to embody in them. They

are objectifications of the human mind with a significance, objective externalized facts with a meaning. In this objective form they carry the impress and portray the structure, vaguely, perhaps, at times, but definitely and distinctly ot others, of the mind which formed them. The quality of the thought and feeling of the desire and accomplishment of their creators has become latent in them. They are so to say, the store-house of their mental energy.

Now, these cultural goods are the only means of setting the educational process into motion, they are the only food for the cultivation of the human mind. Surrounded by the treasures of culture, which society has placed at its disposal, the growing mind, unconsciously at first, more and more consciously later, takes hold of these cultural goods and uses them for its gradual development. When these goods of culture are so used they become educative goods. They were first products of culture, they now become producers of culture; cultivated minds had produced them, they now cultivate minds. But, and that is important to remember, every mind cannot make use of the same cultural goods for its cultivation. What, then, are the goods on which a certain mind can thrive and grow to its full development? This brings us face to face with human individuality. Every man has his own specific way of reacting to the world of men and things. We trace this to the peculiar configuration of his physical and psychical functional dispositions and call this specific mode of reaction, which expresses itself in feeling, willing, and acting as well as in perceiving and thinking, his native individuality. On the basis of this original individuality, hardly susceptible to any considerable change, is built up with the help of objective culture a more developed individuality a Lebensform, a life-form, as Spranger has called it. You are, of course, aware of the numerous attempts made to place the myriad individualities into groups for purposes of classification. The work of Bahnsen, Sigwart, Ribot, Paulhan, Fouille, Stern, Spranger, Jung and Jaspers is, no doubt, known to you. I would like to detain you for a while with the observations in this connection of a great European educationist, George Kerschensteiner, who is not so well known in our country. I venture to do so on account of their fruitful bearings on the question of educational reorganization.

We are all aware, says Kerchensteiner, of two basic psychological attitudes towards men and things—an attitude of contemplation and an attitude of activity. Now pure contemplation does not concern itself with acting on or producing anything in the outside objective world. But it is not for that reason inert, it does work up what it imbibes of the outside objective world. It is not just passively receptive, it involves the inner mental activity of viewing and considering and reflecting and meditating and giving a meaning to the elements of consciousness. It is an attitude of significant, meaningful perception, forming and shaping and creating in the realm of consciousness and in this sense active; although not in the sense of the basic attitude observable in human beings which is directed towards the realization of objective factual relationships in the world of phenomena. This activity of the contemplative, as also of the active attitude, can be either mainly imitative or mainly creative. The imitative activity, in contemplation as well as in action, can be either purely mechanical or may be preceded by a contemplative operation of understanding what it imitates.

Contemplation and action again, can each be of two kinds in view of their aim, end and purpose. You can either be moved to contemplation by

the perception of objects or some of their aspects in the region of sense-experience or by their relations to something beyond experience, the end or purpose is either immanent or transcendent. In the first case it can either be interested in the reality and existence of things, their being and becoming, how they came to be and cease to be, or it can be interested in their purpose, their significance, their value. Both these attitudes of contemplation we can call theoretical attitudes, pure theoretical in the first and teleologic or axiologic theoretical in the second case. The scientific goods of culture are the results of the objectification of these two attitudes. In both of them there is a consciousness of separation not only between the subject and the object, between the contemplator and the thing contemplated, but also between the form and the content of the latter.

In cases where contemplation is not concerned with the validity and reality of things but possessed of their outer or inner appearance, then, although the distinction between the subject and the object still persists, that between the form and the content vanishes. One does not, in such cases, recognize the content by an act of reflection but direct experience. This is the aesthetic attitude. Its objectifications produce the aesthetic, the artistic goods of culture.

The psychological attitude which gets its satisfaction by the contemplation of transcendental value-relationships is called the religious attitude. In some of its extreme forms not only the distinction of the form and the content but even that of the subject and the object is obliterated, as in cases of ecstasy. This is the mystic religious attitude. The objectifications of this attitude produce the religious goods of culture, its religious codes and symbols and ceremonials and, not the least, its religious personalities. For the mystic or the religious experience sets a torch aflame which burns through life, giving warmth and light to all who come close to it.

Now, if we consider the active attitude as against the contemplative, the attitude, that is, which seeks to objectify factual relationships, we find that it too can be of two types according to the nature of its end or purpose. The end or purpose of an action is determined by the value one seeks to realize by means of that action. The satisfaction one desires from the action is due either to the value which the action has directly for the doer or to the value which it has in producing satisfaction in others. The active attitude, then, is either egocentric or heterocentric. The egocentric active attitude can either aim at the acquisition, preservation and expansion of the material apparatus of life or at the enrichment of one's moral personality. We may call it egocentric material in the first case, egocentric-ideal in the second. The roots of egocentric action lie in the soil of self-preservation and self-assertion; those of heterocentric action in sympathy and affection. The heterocentric attitude can aim at the satisfaction of someone, not the doer, or of some group to which the doer himself does not belong; or it may aim at the satisfaction of a group of which the actor is himself a member. We have the altruistic attitude in the first case, the social attitude in the second. A third active attitude is that in which the value of the action to the doer lies in the action itself , it is the a-social active attitude, the objective attitude.

From these considerations Kerschensteiner derives three basic contemplative types— the theoretical contemplative, the aesthetic contemplative and the religious contemplative—and three basic active types—theoretical

aesthetic, religious—each in four variations, the egocentric, the social, the altruistic, and the objective. But pure types are rare; the configuration of individuality depends not only on the dominance of one or more of these basic forms, but also on the varying degrees of intensity in which the several attitudes enter into its composition.

We have now passed, in brief review, over the two essential constituents of the educational process, the various types of mind to be educated, each with its specific dominant quality and the goods of culture, which are the means and instruments of their education, themselves products of the various types of mind. Now the basic axiom of the educational process is that the cultivation or education of the individual mind is possible only by means of cultural goods whose mental structure, wholly or at least partially, corresponds to its own mental relief. The specific mental constitution of the educand determines his original indigenous circle of interest. These interests are directed towards goods of culture which are the products of similar mental constitutions. objectifications of similar interests. At various stages of the mind's development these interests may be said to represent the totality of that individual life and so, in their pursuit, all the aspects of individuality get, so to say, their exercise and attain their growth. This is then followed by grasping similar cultural goods of a higher complexity and the mind gets along from strength to strength in its development. And, what is quite natural, according to the principle of the heterogeny of ends, these interests branch off into newer and fresher side-interests and these sometimes vie with the original ones in importance and vehemence and are responsible for the growth and development of the other constitutents of the individual mental structure. The original technical-practical interest of an actively constituted boy may well grow into theoretical and aesthetic and even religious interest. If, when this branching off into newer interests takes place, the environment fails to place at the disposal of the growing individuality the cultural goods of the corresponding mental structure, these budding elements in his mental growth may never come to bloom and suffer permanent atrophy. You can not hope to educate the theoretically-inclined boy except through the theoretical goods of culture and you can bring him to an understanding and appreciation of the other regions of culture also primarily through theoretical goods. The culture of the mind of the aesthetically-gifted pupil is possible only through goods of the aesthetic type; you will attempt in vain to educate him through goods of the theoretical or practical mental structure. The door to culture can be opened for him only by means of the goods of the aesthetic artistic type. Once this door to culture is opened by the key specifically suited to a certain pupil, many avenues may lead into the vista, for regions of culture are not isolated islands entirely detached one from the other, they are joined to each other by a thousand connecting links. When once the mind begins to assimilate the mental food provided by goods of culture adequate to the dominant feature of its own structure, other mental qualities—and always a number of them are present or manifest themselves at various stages of the mind's growth—also get a chance of developing on goods whose mental pattern corresponds to them. From art to science and technique, from science to art and technique; from technique to science and art a thousand transitions in a thousand nuances are possible. But if some of the forms of psychic structure are entirely absent from a mind, then the cultural goods corresponding to them cannot be the means of cultivating it. We cannot bring the unmusical ear to experience the real beauty of a great symphony;

we cannot hope to cultivate the mind of a colour-blind person through masterpieces of painting. We knock in vain to open out before most of our children the windows to the cultivation of the mind by means of theoretical instruction, for in that age-period the dominant psychical attitude is one of partial activity. Even that precious cultural good, personality, can make its contribution to the cultivation of other minds only through the basic attitudes of a social mental structure, through sympathy, love, confidence and reverence. Even personality can speak to us only in our language—the language of our soul, which is the language of our specific mental structure. Entirely alien structures represented in a personality are beyond our comprehension and we can just pass it by without being any the better for it. Personalities embodying mental structures analogous to our own can grip us as few things can, and help us on in the course of our mental and spiritual development. The flame of culture is transferred more effectively from a soul to a kindred soul than through the agency of material goods. Every cultural good, in short, has an educative value besides the cultural value attaching to it in its own region of culture. This immanent educative value the cultural goods possess only in relation to mental structure which correspond to the mental structure of their producers. "Education." it has been rightly said, "is the individualized subjective revivification of objective culture. It is the transformation of the objective into the subjective mind."

It is one of the most important tasks of scientific education, as also of cultural psychology, to discover these educational values immanent in cultural goods of various kinds. It is also one of its urgent tasks to classify the multiplicity of psychic dispositions into psychological types, mental reliefs and life-forms. Since culture, in its rich diversity and overwhelming totality, cannot at once act as an instrument of education, it has to be divided up into separate cultural systems as adequate means for the education of the corresponding types of mind or the corresponding aspects of a mental structure. But the culture of the individual also implies an organic unity of its various constituents; it is, therefore, the educational psychologist's task to discover how the mind can pass from one dominant psychic attitude to another and how unity can be achieved among the various elements of the mental structure growing into a harmonious personality. For, as Simmel has well said, "culture is the path of the mind from a narrow closed unity, through an unfolding expanding diversity, to a developed expanded unity."

Let us cast a glance now at our schools in the light of our basic axiom. I hear some one say that the view of individualization of education this axiom seems to demand, is nothing new, good teachers in our schools have all along practised it, our Teacher's Colleges have already long been advocating it. Words sometimes deceive. Yes, there has been individual attention to pupils—it does not matter for the argument if the quantity has been infinitesimal—but that has been confined to finding ways and means of introducing individuals to a certain cultural good, and it has never meant selecting different cultural goods for the education of different types of mind. The axiom of congruence between the mind which is to be educated and the cultural goods which are the means of its education demands consideration not only of the subjective but also of the objective side. It requires that schools should not be so one-sided in their instruments of education as they really are. The multiplicity of schools-subjects—a multiplicity that is constantly growing and practically every proposal for reform concludes with a further addition to the number— may make one feel that this charge of one-sidedness

is not well-founded. A little scrutiny will show, however, that it is a very one-sided multiplicity. For these educational media are mostly of a similar kind, they correspond to the theoretical attitude of mind. Even the choice of theoretical goods is very one-sided, for with the exception of some sort of history— which too is usually disjointed information one misses in our curricula all sciencess which deal with the objective relationships of individual to society, with state, law, education, economy, sciences, that is, which could be useful in the cultivation of the social aspect of mind. One further misses in the curriculum goods of the moral-egocentric, goods of heterocentric altrustic, and the heterocentric social, goods of the practical-technical and goods of the objective attitudes of mind; that is, one misses all the goods of culture which can be the most potent means of education of the vast majority of youthful human beings, goods which do not only explain in a theoretical fashion the aims and objects and moral forms of social life but which make the young directly experience these aspects of life and thus help effectively in the development of these aspects of mind. And even in the choice of our theoretical goods we sometimes just lump together the mathematical, the scientific and the linguistic, unmindful of the fact that they correspond to three distinct varieties of theoretical talent. Yet, in spite of these defects, inspite of the obvious neglect of several aspects of mental development, no one can say that the time-tables of these schools are not already full with subjects to overflowing. Where, under the smothering weight of these subjects, is there any room for the pupil's own initiative and spontaneity? How is that to be explained? It is to be explained by the tendency to mistake information for education and by the great prestige enjoyed by what is called general culture. We must hasten, I am convinced to fight both these thoroughly wrong notions. We should learn to distinguish between the informational and the educational values of the various subjects of study and should look upon the school as a place of educating the mind and not of amassing ill-digested information. When we teach many languages we feel we are giving much education. although for purpose of the development and discipline of the mind all foreign languages have a similar quality. The habits of logical thinking can be developed by means of Greek as well as by means of French, grammatical concepts can be grasped in Sanskrit as well as in Arabic, aesthetic perception can be quickened by reading Sophocles or Shakespeare as well as by reading Kalidas or Mutanabbi. From the point of view of the cultivation of the mind the important point is the consideration as to which of these lends itself to more effective use for these educational ends. The natural sciences, similarly, are all good instruments of training in habits of logical thinking and in the formation of exact and precise concepts - one as good almost as the other. The various branches of mathematics share the immanent educative value of logical formal thought and exact concept-formation with the natural sciences and are helpful besides as training in functional thinking by means of analysis and in spatial perception by means of geometry. One foreign language, one of the natural sciences and mathematical analysis with plane geometry should suffice for the education of the capacities latent in the theoretical structure of a mind representing all the three intellectual aptitudes involved. But the education of the mind is apparently not considered enough---a man ought to know and know more and still more. For that is considered to be general liberal education. The goods of culture, adequate only to a certain theoretical mental structure, are heaped one upon the other to the great detriment of the real culture of the mind. A good of culture, to yield its full educative value, requires the singleminded devotion

of a corresponding mental structure which should, as it were get possessed of it, reproduce, reconstruct, reshape it on its own. Such preoccupation with a good of culture demands self-limitation, but it also postulates elements of knowledge pertaining to other regions of culture and it is here that the mind begins to cast its net wider and draws nourishment from the adjoining cultural regions. The introduction to these fresh fields is best secured when the subject's absorbing interest in its work or study brings him face to face with problems where knowledge of other fields of culture is helpful and fruitful. That is the way to general education and not an agglomeration of similar cultural goods, with equal emphasis on all, from begining to end. General liberal education can only be the fruit of a life-time of devoted work on goods of culture corresponding to one's specific mental relief, the training and nurture of one's innate mental capacities and then through this developed agency partaking of the other cultural values whose doors may not be totally sealed for want of the corresponding mental configuration. We may not presume this fruit to fall into the lap of a youth of 16! Many-sideness may be the end, to aim at in the begining is to dissipate mental energy. No, if our educational system is to be reconstructed in the light of the basic axiom of the educational process, it will have nothing to do with this inflated valuation of information nor with this naive over-estimation of an impossible general culture.

But there are obvious difficulties in réconstructing our educational edifice on the foundation of this axiom of congruence between the subjective and the objective mind. It may sound all right in theory, some would say, but how can it work in practice? How shall we discover the mental structures of the millions of boys and girls who will now pass through our nationally conducted schools? Who will distinguish any differentiations of structure among boys and girls of six or seven coming to our Basic Schools? Even if at the age of 11 or 12 you succeed in noticing in a number of pupils the manifestation, say, of the theoretical, contemplative attitude can you with any degree of certainty predict the direction this theoretical attitude will finally take? Will you not be often deceived by passing inclinations into reading the presence of aptitudes which the pupil will very soon practically repudiate? The child is a great experimenter and tries its hand at all sorts of things. It is great at imitation. Both these circumstances may make us assume permanent aptitudes where there is just an ephemeral inclination. Dilotanism, even among grown-ups, is perhaps an infantile survival of these tendencies. Then, a psychical attitude manifests itself at different times in different persons, due partly to its place in the total mental configuration and partly to the total situation in which the individual happens to be placed. These and many other circumstances seems to render the application of the axiom, I have placed before you, difficult in practice. How are we to go forward with educational reconstruction on the basis of this axiom? Can we at all? I feel we can, and although I may not presume to detain you with details, I shall just indicate some of the chief things we shall have to do.

In the early years of the school system which we provide for the children of our nation, we should see to it that instead of initiating the child into several cultural goods corresponding to the same psychological aptitude we should provide the educative goods subserving all or as many as possible, of the apitudes and refrain from making them all obligatory. We should, above all, introduce the goods corresponding to the dominant psychical characterestic of the early age period namely, practical activity. One

can see, as one runs, that the young human beings during this age-period are preeminently practical and active in their attitude and disposition. They think, as it were, with their hands, and learn by doing. They seem to recaptitulate, in a way, the whole history of the human race, whose intellectual work has grown out of the manual. At this stage in life, when boys and girls are bursting with active energy, and almost invariably insist on doing things with their hands, why should we, in our self satisfied stupidity, make them sit silent and sombre brooding over books and swallow irrelevant, unwanted information, getting passively educated by others' grace? Even if our one-sided intellectuals look upon manual work with a degree of superior contempt and sneer at its possibilities as a real instrument of the culture of the mind, we should not hesitate to do the right thing by the education of our future generations. No in spite even of all our Vice-Chancellors the No-More-Vice-Chancellors and the Not-Yet-Vice-Chancellors, in spite of all that the so-called "men of culture" might say or insinuate, we should make educationally productive manual work the chief educational good in our basic schools. If authority be more convincing than insight, it was no less cultured a man than Goethe who said, "There are certain measures which should form the fundamental of all education. With hand-work must begin all life, all work, all art."

Then, during the period folowing Basic Education, when the differentiations of mental structure become noticeable, the axiom of congruence between the subjective and the objective mind urgently demands a diversified system of Secondary Schools or Colleges adequate to the needs of development of the chief types of mental make-up- -theoretical schools of the literary type theoretical schools of the mathematical scientific types, technical schools, art schools, agricultural and commercial schools and perhaps, Teachers' Academies. One thing, however, must be constantly kept in view. We should remember that however scientifically we diversify our secondary education, none of these new schools can hope to be accurately adapted to the specific needs of all individual pupils in an equal measure innumerable, variations are possible within the same type. It is therefore, essential that the whole time of the pupil is not claimed by the prescribed work of the school and that opportunities are given and facilities provided for the pupils to apply themselves spontaneously to aspects of culture not quite adequately represented in the required school programme.

Even in the field of higher education, I think, it is at these points of what may be called "concentrated application" that the real opportunities of insight and revelation and cultural growth lie for each individual. By adopting the axiom of congruence as the guiding light throughout our schemes of educational reconstruction we seem apparently to limit the portion of objective culture which goes to the cultivation of the mind, but we make the mind grapple with the cultural goods which correspond to its make-up, to work on them, to assimilate them, to reconstruct them, to change them, improve them, to live the values inherent in them and to venture to create similar values. We make the mind work and work earnestly, be it in grappling with theoretical goods, be it in applying itself to practical-technical goods. For by trifling with things or trifling with ideas or trifling with words, by just mechanical work or just mechnical learning by heart the mind does not get educated. It gets its culture when it is gripped by cultural values embodied in appropriate cultural goods, when it grasps them, understand them, reconstitutes them, creates them. All such work, mental or physical,

is educationally productive work and it is only educationally productive work that can educate. There is no other royal road to education. Our educational institutions from the Basic Schools to the University will all have to be places of such work. Only so will the goods of culture be made to yield the values inherent in them and the minds receiving education will live and experience those values. The mental energy stored in goods of objective culture by their producers and lying there as latent energy will, by the application of the kindred receiving mind, now transform itself into kinetic energy and help in the growth and development of the subjective mind. At our educational institutions, which shall no longer be places of passive receptivity, but of active experience, the pupils shall have facilities to experiment, to discover, to work, to libe; where work would fashion character and living would shape lives and like all healthy work and like all good life, they will grow into homes of co-operative communities engaged in fruitful co-operative endeavour, with active efficient members exercising initiative and accepting responsibility, through an inner urge for self-discipline, self-realization and mutual helpfulness. The true value of knowledge comes only when it function; and only when its use is harnessed to the service of the absolute values does it reveal its true significance and exercise its liberating mission. In the words of an English educationist "Knowledge is idle in a community if it becomes the private possession of an esoteric coterie. Knowledge has redeeming and life-giving power only when it continually re-enters the life and work of the community." Our seats of higher learning must become temples of such redeeming knowledge and communities of such worth-while living. The reconstruction of our national education in the light of the basic axiom, I have placed before you, will imply nothing less than the transformation of our educational system from a random growth to a consistent whole the transformation of our educational institutions from places of intellectual theoretical one-sidedness into those of practical human many-sidedness, from places of passive receptivity into those of active spontaneity, from places of incoherent knowledge to those of thorough mental discipline, from places of amassing information to those of living and experiencing the values inherent in the goods of culture, from places of individual self-seeking into those of co-operative social endeavour. No reform which falls short of this is worth looking at. To bring about this great reform there is much that psychologist and educationists could do. There is, above all the urgent need of applying their trained minds to the two inevitable sides of the educational process, the objective and the subjective side. The psychological structure of the goods of culture, which are the only available instrument of education has to be carefully studied. The various types of mental-reliefs and life-forms have to be throughly investigated. You have to find the enlightening answer to the two cardinal questions of education: What is the structure of cultural goods, of the diverse items in our cultural heritage? What is the structure of the individualities whose education is our concern? Without a clear answer to them education will grope in the dark. The selection of goods of culture appropriate as instruments for the cultivation of various types of mind, the initial division of the regions of culture and their ultimate possible integration, the problems of the curriculum, that have to be scientifically dealt with—problems usually left to the mercy of complaceent superior whim, comfortable unintelligent tradition or considerations extraneous to the demands of the educational process advocated by ignorant vehemence in places of power. The problem of the classification of schools according to the dominant life-forms the proper canalization of

the main stream of pupils coming from the more or less undifferentiated basic schools to the diverse types of secondary institutions will need your guidance for a right solution. And guidance will not be enough, a fairly numerous staff will have to be trained to perform the work with some degree of scientific reliability in a fast expanding system of national education. Ours is a big country and when our democracy sets about the task of educating its masters—and set about it, it must immediately, if disaster is to be avoided—we shall require an army of teachers so numerous that many are staggered by the mere mention of its size. Now the selection of the right type of teachers and their proper education is a task which cannot be left to chance or hasty improvisation. All educational effort is doomed to ignominious failure if we do not succeed in selecting the persons best suited for this work and in equipping them as effectively as possible for one of the most responsible tasks of society. You will have to tell us as to who shall be privileged to perform this most important cf national services, how to select these teachers. A thorough analysis of the nature of the educators' work, an intelligent determination of the type of life-form where the capacity for such work has to be looked for, an appreciation of the additional qualities for a teacher of a number of pupils, as distinguished from an individual preceptor, will be necessary if you are to give anything like convincing helpful guidance in this important choice. Ample work for our psychologists and educationists, but fascinating work, too, in view of the great possibilities of thought and research as also in view of the promise it holds of rich harvest. I shall not have entirely wasted your time here if I succeed in persuading at least some of you to take up this significant work.

SECTION OF MATHEMATICS

PRESIDENT: R. VAIDYANATHASWAMY, M.A., Ph.D., D.Sc.

THE NEW MATHEMATICS

(*Delivered on January 6, 1948*)

MEMBERS, DELEGATES, LADIES AND GENTLEMEN,

I appreciate very highly the opportunity which has been afforded to me, of participating in the yearly activities of this Congress after a break of many years. The pleasure is all the greater as we are meeting today under the auspices of a National Government which is keenly alive to our technological needs and is trying to plan ahead to future of Scientific research and education in this country. It is well-known that Mathematics occupies a key-position in relation to Scientific research generally, by providing the basic schemata for the accurate description and understanding of natural phenomena, so much so, that if we wish to characterise by a single word the outlook towards Nature, which has resulted in the scientific and technological advances of this age, it should be called the 'mathematical outlook.' We ourselves as a people boast of an ancient culture with innumerable ramifications permeating every department of individual and collective life,—a culture which, as it has survived today, is more of a relic than a living force; in its essential elements, and in its methodology and technique, this culture may be appropriately described as a comprehensive science of the Real, and remains as a unique achievement at the present day. With this record, it ought not to be difficult for us to seize on and assimilate any new element or outlook in any particular age, to participate in working it out, and do our share in the building of a civilisation. In the unfoldment of human evolution, the 'Mathematical outlook' on Nature characteristic of this age, is definitely a new manifestation; its representation in our own indigenous culture is feeble, being limited to a bare recognition of 'sankhya' (number) as a *tatwa*, (basic principle of existence) in very early times and the invention of elementary Arithmetic and Algebra and an approach to the differential calculus, about a millenium ago. From these lowly beginnings, mathematical science has grown through the centuries step by step with the physical sciences, till at the present day, it has woven itself inextricably into our description of, and outlook on Nature. Speaking broadly we may recognise three successive stages in this growth. The first stage is that of elementary mathematics—Geometry, Algebra and Arithmetic, and elementary functions. The second stage is that of Analysis, that is, the rigorous establishment of the number-concept, and the theory of functions of real and complex variables, with the mastery of infinite processes, which now reveal themselves as the characteristic feature of mathematics. It is this stage which has equipped mathematics with its powerful tools and has enriched so many other branches of knowledge & technology, the Sciences of Mechanics & Astronomy, the field-theories and boundary value problems in Physics, and Thermodynamics. It was the spacious age of the 19th century which witnessed this great development of Analysis and its expansion into farflung applications, and left people with a vast sense of power and with the feeling that there was little more that remained to be done in the

elucidation of natural laws and their precise mathematical formulation. But the Time-Spirit delights in providing surprises, and this feeling has been entirely falsified in the sequel. The third stage of mathematical thought, which coincides with our own time, while taking up all the tools of Analysis, operates with ideas and structural-patterns which transcend the limitations of Analysis. It is no accident that this third phase of mathematics has followed so closely the revolution in classical physics; indeed, it was the difficulties of Atomic mechanics and their resolution by means of the quantum and the wave theories, which have helped directly and indirectly to stimulate the more powerful structure-patterns with which present day mathematics operates. It is a fact that we in this country, have so far failed to assimilate in any appreciable measure, this last and most powerful phase of mathematical science. And the reason lies not in the lack of students, for we have capable students willing to learn, but in the lack of organisation of our Universities, and in the fact that our universities left to their own autonomy have no sense of direction. Incidentally, the reason lies also in the fact that we do not have a sufficient quantity of men equipped with a broad scientific culture, to go round, for manning the administration of our Universities. Unless something can be done to remedy this state of affairs, I am afraid we will be left to crawl far behind the front line of scientific progress.

It remains for me to sketch briefly the contours of the new mathematical thought, and to indicate its bearings and its methodology.

If Mathematics is considered to be simply Analysis, its definition would be 'Mathematics is the science of number'; and the objects which Mathematics deals with, would be real number, sets of real numbers, and functions of numbers. But the new mathematics accepts real numbers only as a particular category of concrete objects, and deals generally with relation-structures that is, sets of abstract objects, connected by relations with postulated properties. The relations in question may also be such as to lead to *operations*. In practice, the structures which are of frequent occurence are, the *topological space*, the *partially ordered set*, and the operation-structures, called the *group*, the *ring* and the *field*. The important thing about these structures is their *abstract* character; that is, their elements are not restricted to be of any specified nature (like real number, or complex number or function). It is interesting to observe that these structure-forms are already implied in the genesis of the real number system which is the foundation of Analysis; this accords with the general principle that the new knowledge we obtain must already be present in germinal form, in what we consider as familiar. For in the first place, a cardinal number like 2 is the name of the common quality present in a family of all equinumerous sets—namely, the family of all couples. An equation like $2+3=5$ means that set-union of a couplet and a triplet is a quintuplet, provided the couplet and the triplet have no common members. But the family of all sets is partially ordered. Thus the linearly ordered additive structure of cardinal numbers arises by a a certain restriction from the partially ordered system of sets. The next stage in the development of number is the signed integer. The conception of negative number is often explained by means of the dual experiences of forward and backward, right and left, owning and owing. It may also be explained by saying that the mind already possesses the intuition of group-structure, and seeks to complete it. No objective explanation has ever been advanced, of the law that the product of two negative numbers is positive; the only possible explanation is that the mind already possesses the intuition

of the ring-structure, and seeks to realise it in the system of positive and negative numbers. Similarly, the manifestation of the rational number, may be explained either by the experience of unlimited divisibility of matter, or by the mind already possessing the intuition of field-structure, and seeking to realise it from the signed integers by completing the multiplicative group The final stage of the genesis of the irrational number and the linear continuam, may be called the topological moment in the development of number; here the irrational number arises to answer to the continuity (or more precisely, the local compactness) intuited in the sense-extension. Here, the dual explanation of the stages of development of number, one in terms of the mind, and the other in terms of the objective experience, would not be permissible if we take the European view that the mind is something that is set against Nature and opposed to it; it would however accord with the view of Indian thinkers that the mind is itself the primary aspect of Nature, and that the harmony between the manifestation of the idea and the objective experience is already implicit in Nature.

Thus the structural forms of the new mathematics have a primordial character. The different structure forms have to be studied separately as individual disciplines, though in actual applications they may occur mixed up together—so that for instance, we may have a function-space which is simultaneously a ring, a partially ordered set, and a topological space. It has already been mentioned that these structures are abstract, and therefore of a corresponding generality and universality. Some important applications of these structure-forms may be mentioned. It would be impossible to study the function-spaces connected with microphysical vibrating systems without a background of topology. The theory of representations of groups and rings has fundamental applications in quantum mechanics. The theory of partial order has been applied with great profit to the theory of probability and the Ergodic Theory. Apart from these standard applications, quite an appreciable part of present-day mathematical research consists in the recognition of these forms in older mathematical theories, and a re-investigation of them from the new view-point; as for instance the calculus of variations and functions of a complex variable. It is certain that it will take several decades of research on these lines to assimilate the new forms to current mathematical thought.

But the greatest significance of the new mathematics has yet to be mentioned. So long as one considers Mathematics as co-extensive with Analysis, it would be, justifiable to say that Mathematics is merely an aid to calculation, or a technique of manipulation. It would be a tool, to be used after a scientific problem has been reduced to the terms of number and function. But such a description is no longer applicable, as there is no necessary reference to number in the basic disciplines of the new mathematics, or even in some of their specific applications. For instance, the classical propositional calculus, as well as certain new unorthodox systems of logic like Intuitionist logic, or the logic of strict implication can be brought under the structural forms of the new mathematics, and investigated, for all the world as a regular mathematical discipline. Another very remarkable and instructive case is that of Projective Geometry which developed from the classical geometrical system of Euclid's Elements. Poncelet in his *Traite' de Geometric Projective,* gave a synthetic exposition of Projective Geometry without making use of co-ordinates, but it is known from recent historical research that Poncelet did use analytic methods in his actual work, though he suppressed all reference to co-ordinates in his published

exposition.* In other words, historically there had been no real separation of Projective Geometry from Analysis. It is only under the impetus of the new mathematics, that Projective Geometry has displayed its real form as a mathematical discipline which had absolutely no reference to Number and Analysis. The available books which treat Projective Geometry as an aximatised discipline, generally concern themselves with treating a set of necessary conditions which progressively reduce Projective Geometry to co-ordinate geometry usually so called. These instances suffice to show that the new mathematics cannot be described as a mere technical device of calculation, that it is rather a way of looking at things in general—a methodology of thinking. This raising of the status of mathematics from a mere specialised discipline to an aspect of a broad humanistic culture is one of the most arresting and significant features of our modern scientific civilisation. It is because of its character as a general methodology of thinking that mathematics has found applications beyond the scope traditionally ascribed to it. It is clearly a matter of the utmost importance for general scientific progress, to make widely known and to popularise this aspect of modern mathematics to the intelligent and cultured public. It is a matter for gratification that a movement for this purpose has been started about a decade ago in the U. S. A., and is doing excellent work with the journal called Scripta Mathematica as its organ.

The status of mathematics as a method of thinking and reasoning which is an essential element of modern scientific culture, is the positive and final answer to the question which has been and is being asked by persons who claim to be practical—'What is the use of abstract mathematics?' The humanist can of course answer that personality is the highest value, and that all values whose pursuit integrates and develops personality must be accepted as useful. But ordinarily the persons who are capable of seriously putting this question, are precisely those who would not be convinced by this answer. It will then be necessary to counter this question by another which is more difficult to answer—What is the use of Use? But very often the same question is put with a greater show of reason, in regard to some particular topic of mathematics. For example, the Vice-Chancellor of an Indian University asked me in all seriousness 'what is the use of topology and abstract spaces?' Or, one may feel troubled by the question whether the Analytic Theory of Numbers, or the laws of asymptotic distribution of primes can be said to be 'useful' in any sense of the term. I recall in this connection, the late Prof. G. H. Hardy, in whose death reported last month, the world has lost a great mathematician who created new methods in the Analytic Theory of Numbers. Prof. Hardy was not a protagonist of the new mathematics I have been describing, but an analyst using and furthering classical methods; in regard to the question of the 'use' of such subjects as the Analytic theory of numbers, he was practically certain that they would never turn out to be of any use. He expressed this conviction in his characteristic mock-serious vein, by challenging anybody to prove that pure mathematics is of the slightest use to anybody. If the issue is to be raised in this form, one is bound to reply, that it will be even more difficult to prove that pure mathematics cannot be of any use. After all, a question of this kind can be decided only on the basis of the general view we take of Nature, and its relation to the human mind. If we take the typically European view, which I have already referred to, that the mind is something set up in opposition to Nature, functioning as its interpreter and partly as an independent thinking organ, then it is

* E. T. Beu., *Development of Mathematics.*

purely a toss-up, whether any particular cogent idea-form does or does not have its counterpart in some typical process of Nature. If on the other and we adopt the traditional Indian view that Nature is triple, that is, it is a complex of three mutually linked-up but distinguishable *lokas* or objective worlds, then the mind is a primary form and the self-interpretative form of Nature, and the cogent ideational formations in the mind contain the clues to the forms of her stock processes. It is true that Science has meant so far, both to the West and to us, the investigation of only one of these three *lokas*—in fact, of the material or outermost husk of Nature. But there are traditional disciplines for experiencing these worlds, and some time or other humanity is bound to arrive at a perception of them. Then Science will come to its own, and will come to mean what it has always claimed to mean, the understanding of the laws of Nature as a whole, instead of a section of Nature. Indeed in some of the conceptions about the ultimate constituents of physical Nature, and in the wave-corpuscle duality of micro-physics, we seem to have arrived, though by a devious inferential path, at the portals of a subtler world which we have yet to penetrate in experience. It is extremely probable that the repertoire of this triple Nature consists only of a few very general structural, patterns which she mixes with amazing skill, and disguises in innummerable contexts, in order to bewilder and attract the Self of Man. It is certain that when the mind is concentrated on any system of ideas, for example, a mathematical theory, some substance which may be called mind-stuff, following the mathematician Clifford, is thereby thrown into Stress and movement, and forms structural patterns. Supposing the mathematical theory in question is the theory of distribution of primes, we may counter Prof. Hardy's challenge, by challenging any one to prove that the corresponding structure-patterns of mind-Nature can be described and elucidated without appealing to the properties of primes.

We have seen that Mathematics is essentially abstract in the sense that it is concerned with the pattern of the relation-structures manifested in natural experience. It is true that all science is abstract and formal, in that it abstracts only the significant elements from the total complex of a situation; but Mathematics is abstract in the second degree, since the forms and patterns which it studies are purely conceptual and devoid of sensory elements. The symbolism characteristic of mathematics arises from the necessity of holding separately in thought, the elements which go to make up these patterns. The methodology of mathematics was first elucidated by Hilbert in his famous 'Theory of Proof.' In trying to discover what constituted a proof, as understood in mathematics, Hilbert asked himself the question "What does a mathematician really do when he solves a problem." He found that firstly there was an abstraction of the significant elements of the problem, secondly a representation of these significant elements by symbols, and thirdly, a play or operation with these symbols according to certain accepted rules. Even though the original acceptance of these rules might have been motivated by the meaning of the symbols, still the operations with the symbols in accordance with the rules is purely mechanical without any reference to their meaning. In the fourth and last stage, the result of the operation with the symbols leads on interpretation to the solution of the problem. According to Hilbert these are the characteristic features of any deductive process; the accepted rules according to which the symbols are operated are the *postulates* of the deductive process. Hilbert called the mechanical play with the symbols *mathematics,* while the processes in the mental background which supported and guided the play by a consciousness of the meaning of the symbols were generally called *'metamathematical'*

The interest in this analysis of the deductive process into a mathematical or formal part, and a metamathematical part lies in the fact that it applies also to logic. Taking account of this, we may define a 'deductive system' in a precise manner as follows. Let K be any abstract set between the members of which there may subsist certain relations R_1. $R_2, \ldots$, Rk. Let certain properties of these relations be considered and expressed as propositions A_1. $A_2, \ldots$, An. Assume now a system L of logic consisting of (1) propositional calculus, or the logic of the connectives, and, or, not, if —then, between propositions not analysed into subject and predicate (2) logic of particular and universal propositions (3) a definition and properties of at least the integers or finite cardinals, and if necessary of the transfinite cardinals. All propositions which can be derived from A_1, $A_2, \ldots$An by such a system of logic are said to form a *deductive system.* It is clear that logic itself can be exhibited as a special case of such a deductive system. If P is a proposition expressing any property of the relations R1 R2 ....Rk, it need not be the case that either the proposition P or the proposition not-P is derivable from A_1. A_2 ....An by the assumed system of logic; if neither P nor not-P is thus derivable, P or not-P is called an *undecidable* proposition of the deductive system {K; R_1, R_2; Rk; A_1, $A_2, \ldots$, An; L.} A deductive system which contains no undecidable propositions is called *complete.* If the deductive system is incomplete, then a method of rendering it complete is to go on adjoining to A_1, $A_2, \ldots$An any undecidable propositions which may present themselves at each stage. The totality of deductive systems thus arising from a given incomplete deductive system, are said to form a *deductive theory.* Thus, the three basic relation-structures, viz, topology, partial order and Modern Algebra, which I mentioned as the subject-matter of the new mathematics, should not be considered as deductive systems, but as deductive theories. This because in a subject like, for instance, topology, we not only study a general system of postulates which result in topological structure, but are also interested in knowing what further postulates we should add to arrive at spaces familiar to us, such as Euclidean space or Hilbert space. Similarly, Projective Geometry is not a deductive system, but a deductive theory; for, starting from the most general conception of projective geometry, we are, as I already mentioned, interested in finding out, what further assumptions we should make in order to arrive at ordinary coordinate geometry. Thus Hilberts' analysis of the deductive process leads us to the *definition of* mathematics as the class of all deductive theories. The real number, which is the original subject matter of Analysis, would arise on this view, from the deductive theory of linear order. More precisely on the lines of Dedekind, it would be defined as a section of a dense countable linearly ordered set without first and last elements. Now, I have indicated in my book* how the theory of sections may be extended to partially ordered sets. It may be expected that those partially ordered sets every section of which is a cut would have an importance for generalised Analysis similar to that of the real number. It is not known how such sets may be characterised, or whether they can be defined in terms of real number.

This view of the methodology of mathematics is called *formalism,* and accords best with the actual thought process of the mathematician at work; it has the advantage that it sees no essential difference between logic and mathematics, and presents them both as instances of the deductive system consisting of a symbolised, or formal or mathematical part, and a

* *Treatise on Set-Topology*—Part I, ch. III.

metamathematical part. There are two other views which may be taken, of the nature and methodology of mathematics. These are called logistic and intuitionism. Logistic is broadly similar in outlook to formalism, with the difference that it is less general, and prefers to regard logic as the foundation and mathematics as the superstructure. Intuitionism differs sharply from the other two, in its reaction to the Infinite; and also denies that mathematics an be completely formalised. To the intuitionist the unending ordered system of the cardinal integers 1,2,3,....is given to us by intuition, and constitute the primary objects of mathematics. In his view, mathematical existence is the same as constructibility, by a mathematical process; in other words he denies the principle of excluded middle, except in the case of a finite number of possibilities, and does not admit the *reductio ad absurdum* proofs based upon it. For a sample of intuitionistic reasoning and procedure, the article on 'Intuitionist theory of linear order' by Dr. K. Chandrasekharn, published in the Mathematics Student, a few years ago, may be referred to. In this connection, it is impossible not to be struck by the fact, that the infinite was a frequent subject of discourse and dispute in classical Indian dialectic, and that the unrestricted use of the principle of the Excluded middle was discarded in Advaita-vada, for apparently much the same reasons as in Intuitionism. The infinite of the Brahma-Vada and the Indian Scriptures, was no doubht something which was beyond the power of thought to seize and characterise. It is therefore something which is more radical than the infinite which is presented in the well-defined contexts of mathematics. It must nevertheless be admitted that in mathematics, which contains the basic principles of our scientific outlook, the Infinite has left its traditional refuge in the transcendental realms, and has come out into the open. For, whatever view we take of the nature and methodology, ot mathematics, it is fundamentally a science of infinite processes, a science of the positive infinite; indeed, every technological application of the differential calculus may be viewed as a traffic with the Infinite. At every step in mathematical thought we contact the Infinite and meet it frontally, and it may even be said that we seize and hold the Infinite, or at least its tail. It follows that the foundations of mathematics, and the philosophy of both Analysis and the new mathematics I have been describing, would be a study, which comes as a natural continuation of our classical philosophic record; it would be a fit material for an analytical Intellect, sharpened on the heritage of the Indian dialectic. It is however a fact that no student of Indian or European philosophy in this country has so far entered into this realm. This neglect can no doubt be explained by the presence of various difficulties and barriers of thought. But the interests involved are very great, since it is a question of revivifying our ancient culture, and bringing its powers to bear on the present day problems of modern science. And the barriers can easily be broken down if Universities and learned institutions offer special inducements for such a study. It is all the more necessary for these bodies to bestir themselves on this matter, as the logic which is taught in our graduate and Honours classes is an old-fashioned stratum of the subject, which is completely out of date at the present day. The logic, studied at the present day, is formalised to the extent of being completely symbolic; in this form, as I have already explained, it is a deductive system or deductive theory, as conceived in the formalistic doctrine, and can be hardly extricated from mathematics. On the other hand as taught in the formalist view, there must exist concurrently with the symbolised or 'mathematical' part of logic, a 'metamathematical', or as we may call it a 'metalogical' part, concerned with the meaning of the symbols, and this metalogic must be closely connected

with the structure of language, and linguistics. Thus mathematics, logic and linguistics form a connected complex, intertwined at their roots. Indeed, a recent view of mathematics that has been advanced and developed, is that mathematics is a language, and those elements in mathematical thought that are to be called grammar and syntax of the language are separated and described. This is perhaps a development that could be expected, from the formalistic view of mathematics, with its two-fold division into mathematics and metamathematics. It is sometimes said that the evolution of Science is towards unification. If this is correct, this intimate synthesis between logic, mathematics and linguistics is a most gratifying result of modern thought, and invites study and elaboration from this country.

SECTION OF GEOLOGY AND GEOGRAPHY

President : P. K. GHOSH, M.Sc., Ph.D., D.Sc., D.I.C., F.N.I.

MINERAL SPRINGS OF INDIA*

(Delivered on January 5, 1948)

I. INTRODUCTION

I must thank you very much for the great honour you have shown me in electing me your President at this Session. And I must also thank the members, particularly those residing in that part of the world which is now known as Pakistan, who, either by contributing papers or otherwise, are actively participating in our deliberations. Geological and geographical investigations would be all the poorer if the workers in the two man-made sub-divisions of this sub-continent were to carry out their work in complete isolation after having maintained a comprehensive and regional outlook on the relevant problems all along.

I did not realise how light-heartedly I had accepted your offer, until it dawned on me that an address of some kind is expected of the President on this occasion. As I looked through the contributions of your past Presidents from year to year, I was at a loss to select a subject suitable for this occasion and it has not been without a certain amount of misgiving that I have chosen the 'Mineral Springs of India' as the theme of my address. I make no apology for the subject itself, but for my own imperfect knowledge I crave your indulgence.

Mineral springs have a special appeal to the field-sciences of geology and geography, no less than to the medical sciences in their relation to the public health. Balneo-therapy is a fairly widely established practice and popular in many of the advanced countries of the world to-day.

The discoverer of the spring is perhaps the local shepherd or the woodsman. In his wake comes the thirsty traveller who quenches his thirst or warms his cold and tired limbs in the water and feels all the better for it. If there be any virtue in the water, the word goes round and hallowed by faith and tradition in course of time, the place becomes one of pilgrimage for people sick in body and probably also in mind. The geologist, the geographer and the medical man make a scientific survey which the alert commercial mind is quick to make use of in turning the suitable springs into spas. People of means in order to recoup their health and also for a break in their usual routine of life resort to such establishments. Not only do they drink and bathe in the water, but their treatment is enlivened by many social interludes in a care-free atmosphere. At the end of the course of treatment, they return to pick up the threads of their old life with a vigour of mind and body which does credit to the spa-treatment.

The water may also be bottled and sold in the farthest corner of the earth with prescriptions for its intake. A class of people firmly believe in the efficacy of the water, but whether it is the care-free life at the spa, or the label on the bottle, or the intrinsic qualities of the water, which are largely responsible for the cure or at least a temporary relief of the ailments, is to be decided by the medical man and the psychologist between them. The task

---

*Published by the permission of the Director, Geological Survey of India.

of the geologist and the geographer comes to an end as soon as they have drawn the attention of the public to certain aspects of the springs, *viz.*, their location, and as much as possible to their physical and chemical characters.

In many advanced countries, such information as the field—and the medical sciences yielded has been utilised in the establishment of large industries. Surprisingly enough, India's efforts so far to commercialise these natural resources have been sproadic and negligible. It is a fact that from time immemorial the inhabitants of this country have been aware, although in an empirical way, of the virtues of mineral springs, and even such as occur in inaccessible places are generally places of pilgrimage or the sites of annual fairs, the water being resorted to for baths and drinks. It is, therefore, not surprising to discover that several sacred places of pilgrimage in India, such as Badrinath in the Ganges drainage area in the Garhwal Himalayas and Jumnotri in the Jumna basin in the adjacent area of Tehri, Sitakund and Rajgir springs in Bihar, Bakreswar in the Birbhum District, West Bengal etc., are at the sites of well-known hot springs. Several of these springs are looked upon as offering a cure for specific types of diseases, *e.g.*, skin-disease, rheumatism, goitre and even leprosy. I have no knowledge by what process of investigation the ancients were able to establish the properties ascribed to the springs in question, nor am I in a position to say that the claims will bear examination and confirmation by the modern medical sciences.

The reason for the lagging behind of commercial enterprise is not far to seek. The fact that most of the important springs are either privately owned or their ownership is vested in religious bodies, seems to have retarded their commercialisation.

Since the publication of the papers of Newbold[10], Buist[1], Macpherson[8] Sclagintweit[14], dealing either with cataloguing or describing the medical properties of the springs known to them at the time, the Geological Survey of India from quite early in its history has continued to interest itself in the subject. Its first Director then designated Superintendent), T. Oldham,— —recognising the importance of the subject prepared his exhausive catalogue of over 300 hot springs in India[11], which was edited by his son R. D.Oldham and published in the Memoirs[11] of that Department. Since then detailed descriptions have appeared, which lie scattered through different periodicals, of several thermal springs of India. T. D. La Touche, in 1918, brought the list, especially of those springs which are reputed to possess some medicinal qualities or are charged with mineral matter, up-to-date . LaTouche's work[7] forms the basis of all later work in that line. In this connection mention should be made of the article 'Mineral Waters of India' by Dr. K. S. Ray[13] published in the Journal of the Indian Medical Association, Calcutta in 1932.

The analytical data on the chemical composition of certain springs are now available in some of the public health laboratories.

The estimation of the radio-active properties of some of the mineral springs of Bombay-Sind-Baluchistan by Fathers Sierp and Steichen [15-17] of the St. X'aviers College, Bombay, of the Rajgir springs, by Professor N. C. Nag[9] of the Bose Institute and Mr. N. K. Chatterjee[2] of the Bengal Public Health Department are notable contributions in the field of investigation of mineral springs of India.

Lastly, it must not be forgotten that we are heavily indebted to the excellent work of the Survey of India whose officers faithfully mark the sites of natural springs on the topographical maps published by them from time

to time. All the known springs of India have been indicated on these maps which are indispensable in the field investigation of the geological features of the springs.

WORK OF THE GEOLOGICAL SURVEY OF INDIA, 1939-41

Quite early in the century, Sir Thomas Holland[6] pointed out that although India is endowed with large numbers of thermal and medicinal springs, no attempt had been made to turn these resources into account. I have showed earlier the efforts of the Geological Survey and others to draw the attention of the public to the existence of such springs; matters however remained where they were until 1939, when Sir Cyril S. Fox, the then Director, Geological Survey of India, and one to whom India owes so much for making known the practical aspects of geology, took the initiative and proposed an investigation of the mineral springs of India. The investigations were to be systematic and to cover all aspects, *viz.*, the geological, chemical, and even commercial. It was also planned that there should be the closest collaboration with the Indian Medical Service regarding the investigation of the therapeutic properties of the waters. As however the requirements of the war which soon broke out precluded the pursuit of an elaborate scheme, the investigations were confined mainly to the field radioactive and chemical studies of the springs by a few officers of the Geological Survey of India, who were however generously helped in the analytical work by the King Institute, Guindy, Madras, Public Health Laboratories, Poona, and the All-India Institute of Hygiene, Calcutta, under the direction of the Director-General, Indian Medical Service. I need hardly say that without such help very little knowledge would have accrued regarding the composition of the waters. As the demands of the war grew more pressing, even the field investigation of the Geological Survey had to be stopped to enable this department to deflect the activities of all available officers to the pursuit of investigations connected with its war effort. I will now tell you briefly the results of the work of my colleagues on the Survey, Messrs. B. C. Gupta, P. K. Chatterjee and P. C. Roy with whom I was associated. In this connection I must also acknowledge with deep gratitude the benefit I derived from the many profitable discussions I have had with Sir Ramnath Chopra, our General President, whose advice I sought on many occasions and who was keenly interested in the subject. The field-work was carried out only during 2 field seasons, 1939-40 and 1940-1941 after which the investigations came to an end. In the course of this period, most of the important springs of Bihar and Bombay, and some of those in the United Provinces, the Central Provinces, the Punjab and Bengal were examined and in all 112 springs were reported upon.

II. SCOPE OF THE INVESTIGATIONS.

During the field investigations, the geology of the area where springs occur was investigated, the flow of the springs and their temperature measured, also their radon content determined. Other gases, such as CO_2 and H_2S which are easy to detect, when present, were also collected and tested. The PH value of the waters was also determined on the spot. Samples of the water were collected for chemical analysis, and the final determination of radon and of radium salts, if any, in the laboratory. The residue obtained after the evaporation of samples of water were occasionally subject to spectroscopic analysis which detected minute quantities of rare elements undetected in chemical analysis. A note was also taken of such therapeutic

reputation as the waters locally enjoyed. Finally samples of water were bacteriologically examined and the suitable ones bottled and sent out on trial tests to people in all walks of life to ascertain if they had any effect on health.

I. GEOLOGICAL ASPECTS.

(a) Geological mode of occurrence : Certain geological conditions are deduced from the way springs are distributed. Thus when a group of springs occur more or less along a line they are taken to indicate a line of fault or dislocation along which waters from deeper regions emerge at the surface. In the case of a limestone region or jointed rocks, springs may issue along such fault-planes when present, but more often they do not, and issue instead, along solution channels in limestone or orifices placed along the joint-planes, the springs being irregularly distributed on the surface in such cases. Springs lining up valleys are taken to indicate the local ground-water level. In the case of thermal springs, the source of the water is deeper-seated than that of cold springs.

(b) Distribution of Mineral Springs : There are four main broad belts in which the majority of the mineral springs of India occur, *e.g.*, (1) Bihar—(i) in a belt more or less parallel to the coalfield boundaries, (ii) in Rajgir area and (iii) in Monghyr area ; (2) along the West Coast of India, in the Ratnagiri, Thana, Kolaba and Surat Districts ; (3) Sind-Baluchistan area ; and (4) the Himalayan belt. (vide Map).

There are besides other areas where a small number of springs occur following the general tectonic trends, *viz.*, in the Mahanadi Valley in Orissa, in the Chittagong District in East Bengal. Besides these, springs occur in Assam, at Bakreswar near Suri, Birbhum district, and in Darjeeling district, West Bengal and in Sikkim and in parts of South India. Except the Bakreswar springs of Bengal, the other springs mentioned in this paragraph and those under (3) and (4) in the foregoing paragraph could not be visited during the time at our disposal.

A brief account of the geological and other features of the more important groups of springs visited are given below.

From the general consideration of the broader features, it is assumed that the springs of the western part of the peninsula are related to the meridional dislocations of the trap country as are known to have affected the peninsula in the Tertiary era, the Bihar ones are related to the East and West post-Gondwana faults, the Himalayan ones are probably related to the local thrust-planes and faults. In course of the field-investigations evidence was noted generally of the existence of zones of crushing and brecciation at the sites of the springs, especially the hot springs, although such evidence was by no means universal.

BIHAR SPRINGS :

HAZARIBAGH, MANBHUM AND PALAMAU DISTRICTS: The hot sulphur springs (Warmbrunn and Lundwigsquelle type) at CHARAK (24° 1' : 86° 25') JHERBARI (23° 42' : 86° 46'), SHEOPUR (23° 40' : 86° 35') and TANTLOI (23° 41' : 86° 44') in Manbhum District, and JAROM (23° 50' : 84° 30') Palamau District, and the alkaline waters represented by the KAWA GANDHWANI series of springs (23° 44' : 85° 23') in the Hazaribagh District are situated in the Archaean terrain in zones more or less parallel and close

to the boundary of the Gondwanas, and are related to post-Gondwana faulting. The Archaeans are composed of pegmatite, quartzite, amphibolite, aplitic and granitic gneisses.

The Aix-Les-Bains type of hot sulphur springs of SURJAKUND (24° 9' : 85° 38') and DUARI (24° 8' : 85° 9') in the Hazaribagh District are situated also in the Archaeans, composed of pegmatite, aplitic granite and quartzite. The zones in which the springs occur are heavily silicified.

Two cold springs, *viz.* PATALSUR (24° 10' : 85° 37') on the Grand Trunk Road near Barkatta Dak Bunglow, and the spring at the summit of the PARASHNATH HILL, both in the Hazaribagh District are also situated in the Archaean gneisses. Their flow fluctuates in different times of the season, the water being derived from the surface or near surface sources. The water resembles the Upper Bavarian Wildbad-Traunstein type of water in mineral composition.

MONGHYR DISTRICT : The "Simple" or "Indifferent" thermal waters of Monghyr district, so called on account of their very low mineral content, occur in a line extending over a distance of 30 miles or more along the strike of the Kharagpur hills in what appears to be a zone of faulting in the Archaean quartzite, with a porphyritic granite occuring at the base of the quartzite. The springs, except for PHILLIPSKUND and SITAKUND at the northern extremity of this zone, are confined to the Kharagpur hills. Beginning with SITAKUND and PHILLIPSKUND in the north, the zone in which the springs occur take a southerly direction to the RISHI, RAMESWAR, LACHMISWAR and BHOWRAH KUNDS and then turn to the South-West to the springs at BHIMBAND (25°4' : 86°24') and BHARARI (25°7' : 86°21')

Amorphous siliceous material is deposited by many of the springs. The copious waters of Bhimband collects into a steaming rivulet filling the valley in a cloud of rolling vapour.

PATNA AND GAYA DISTRICTS : The Simple or Indifferent thermal springs of the Rajgir group occurring in Patna and Gaya districts, emerge out of Archaean quartzites as in the case of the Monghyr springs. They occur in three distinct series, *viz.*, (1) The RAJGIR SPRINGS in Patna District, (2) the TAPOBAN SPRINGS, and (3) the AGNIKUND SPRINGS of Gaya District.

THE RAJGIR SPRINGS (25° 1' : 85° 25') ; altitude : 200 feet. There are more than a dozen thermal springs on either side of the Betarni river, along the foot of the Baibhargiri and the Bipulagiri—at a distance of about a mile from Rajgir Kund Station, the southern terminus of the Bakhtiyarpur —Bihar Light Railway. The spring site can also be reached by motor from Patna through the sub-divisional town Bihar Sharif about 14 miles to the north-east.

The springs issue through fissures in the Archaean quartzites. Evidences of local disturbance resulting in fracture and brecciation are frequently met with in the quartzitic formation. The thermal springs have followed the deep fracture planes thus caused.

THE TAPOBAN SPRINGS (24° 55' : 85° 19') ; altitude : 300 feet. These are situated about 12 miles to the W.S.W. of Rajgir, in Gaya District.

There are four springs in an E.—W. line along the foot of the highly jointed quartzite hill. The westernmost of these is called SANAT ; the next to the east is SANATAN, the third SANATNANDAN and the easternmost is called SANATKUMAR, alternatively, BRAHMAKUND.

THE AGNIKUND SPRINGS (25° 0′ : 85° 30′), altitude : 200 feet. The spring site is situated about 8 miles to the E.S.E. of Rajgir at the foot of the quartzite ridge.

Besides the main spring, AGNIKUND, there are several minor springs along the foot of the quartzite ridge. The combined flow of these is copious.

BOMBAY.

The enormous expanse of country in Western India, covered by the vast basaltic shield of the Deccan Trap lava flows, is singularly devoid of mineral springs but for the series running north and south along the coastline between the sea and the Western Ghats. At its northern extremity the series has the famous DEOKI UNAI group in Bansda State and at its southern end occur the RAJAPUR springs in Ratnagiri District.

Beginning with the VAJRESHWARI SPRINGS of Thana District, the southern portion of this series stretching over Thana, Kolaba and Ratnagiri Districts, has been examined. Excepting the RAJAPUR (UNHALA) spring of Warmbad (Saxony) type (alkaline), the others are chloride or saline waters, the more heavily mineralised ones resembling the Leamington and Marienquelle types of water.

THANA DISTRICT—At the north-western frontier of the Bhiwandi *taluka*, the course of the Tansa river is marked, for a distance of about three miles, by the presence of a number of mineral springs. These occur either in the bed of the river or close to its banks and are collectively known as the VAJRESHWARI SPRINGS (19° 29′, 19° 30′ : 73° 1′, 73° 2′).

KOLABA DISTRICT—Three groups of springs occur in this district, *viz.*, UNHERA SPRINGS (18° 33′ : 73° 13′) ; SOV SPRINGS (18° 5′ : 73° 23′) ; and VADAVALI SPRINGS (18° 4′ : 73° 27′).

RATNAGIRI DISTRICT—Seven groups of springs occur in this district, *viz.*, KHED SPRINGS (17° 43′ : 73° 24′) ; UNHARA SPRINGS (17° 37′ : 73° 19′) ; ARVALI SPRINGS (17° 19′: 73° 31′) ; TURAL SPRINGS (17° 17′ : 73 32′) ; RAJWADI SPRINGS (17° 15′ : 73° 34′) ; SANGAMESWAR (PHANSAVNA) SPRINGS (17° 12′ : 73° 35′) ; and RAJAPUR (UNHALA) SPRING (16° 39′ : 73° 32′).

CENTRAL PROVINCES.

CHHINDWARA DISTRICT—ANHONI (BURRA): (22° 35′ : 78° 36′). The spring is situated on the Deccan Trap formation about eight miles from Matkuli along the Chhindwara—Matkuli Road. Matkuli is again on the Piparia-Pachmarhi road being about 13 miles from Piparia Railway Station on the G. I. P. Railway.

HOSHANGABAD DISTRICT—ANHONI (CHHOTA) : (22° 37′ : 78° 21′). The hot spring is situated on the Deccan Trap formation close to Anhoni village in Sohagpur *tahsil* about 9 miles to the south of Piparia Railway Station on G. I. P. Railway.

These two thermal springs occurring in the trap country are low in mineral content, the first one resembling the indifferent water of Trinkquelle—Wildbad type and the second which is a bicarbonate type resembles Vichy water diluted 10-times. There is H_2S in addition.

PUNJAB.

GURGAON DISTRICT—SOHNA HOT spring, altitude 650 feet.

It is situated in village Sohna, nearly 34 miles from Delhi where quartzites of the Delhi series plunge into the alluvial planes.

The hot spring (temperature 44°C=111.2°F) issuing through quartzite is largely resorted to for bathing and drinking. The spring has been partly commercialised, the rights of the private baths being auctioned annually.

The water has the reputation of curing skin diseases of various kinds. Spectroscopic examination has revealed the presence of numerous rare elements in the water. Although the spring is enclosed in a masonry structure, chances of pollution have not been entirely eliminated. The water, like that of ANHONI (CHOTTA), C.P., is also bicarbonate type, resembling mild Vichy Type of water.

UNITED PROVINCES.

The United Provinces springs are cold springs.

BANARAS DISTRICT, IN AND AROUND BANARAS CITY (25° 19′ : 83° 0′)

BRIDHKAL AND GAIBI WELLS (COLD)—These are two well-known. wells.

BRIDHKAL WELL, the water of which resembles the alkaline water of Apollinaris type, is in the Banaras City itself and is resorted to for washing and drinking purposes.

GAIBI WELL is in the outskirts of the Banaras City. It is also used for drinking and washing purposes, the water resembling the alkaline water of Wiesenbrunnens, Bad Salzburg.

Both the wells have a reputation for inducing appetite and having slight aperient properties.

The wells are situated in the Indo-Gangetic alluvium.

DEHRA DUN DISTRICT—MUSSOORIE (30° 27′ : 78° 4′) and LANDOUR (30° 28′ : 78° 6′).

A group of cold springs occurring in this area have been investigated. Of these, the MOSSY FALL SPRING has been analysed, the water showing a resemblance to the Evian Water Type, an indifferent or simple water.

The area consists mostly of limestone or limestone and shale belonging to the Krol system.

The springs are cold and have a reputation for removing acidity and inducing appetite. The springs are situated in an environment of great natural beauty and are fairly easily accessible.

RAJPUR—SAHASRA DHARA (SANSADHARA) COLD SULPHUR SPRING (30° 23′: 78° 7′).

The spring is situated about seven miles to the N.N.E. of Dehra Dun, and about 2½ miles to the E.S.E. of Rajpur,in the Dehra Dun District, in one of the most magnificent Himalayan gorges. The nearest railway station is Dehra Dun. The spring may be reached from Rajpur which is situated seven miles to the north of Dehra Dun on the fine Dehra Dun— Mussoorie motoring road. A footpath leads from Rajpir to the spring site, a distance of 2½ miles.

The spring issues through limestone in the gorge of the upper reaches of the Baldi Nadi. It is much resorted to for bathing and drinking and is said to have many curative properties. The water is not protected from any chances of pollution. The water is clear and smells of H_2S. The water resembles that of rinkquelle, Bad Nenndorf.

The characters of the springs referred to above are summarised in the two tables 1 and 2 (vide appendix).

(c) Influence of the environment on the character of the water : The character of the geological environment is reflected in the mineral composition of the water, the spring varying in composition according to the nature of the country rock through which the water emanates. As a general rule, the waters emanating from the Archaean terrain, are fairly highly radio-emanative and of low mineral content, those emerging in the basltic plateau, low in radium-emanation and high in alkaline earths "Ca and Mg" and the sulphate and chloride radicals. On the other hand, springs emanating from limestone are high in calcium (Ca") and the bicarbonate (HCO_3), carbonate (CO_3) and also contain varying amounts of the sulphate (SO_4) radicals.

(d) Temperature of the water : Some of the waters emerge cold, others are lukewarm, while still others attain a temperature of nearly the boiling point of water. The highest temperature measured so far is that of the Surajkund in the Hazaribagh District which records a temperature of 87°C. It is interesting to note that practically this temperature is also recorded by La Touche[7] indicating a constancy of temperature of the waters of the spring. During the two yeats of the investigation we have had opportunities of measuring the temperature of some of the hot springs several times in the year, in the winter, in the summer and during the rains. The temperature recorded is practically constant for each spring.

It is commonly reported that the cold springs are warmer in the winter and colder in the summer. To the ignorant village folk this is miraculous and connected with something bordering on the supernatural. The temperature of such springs has been measured and when the flow is fairly large, is also found to be practically constant. The explanation of the so-called supernatural phenomena lies in the fact that within a short distance of the surface of the earth, the ground water reservoir form which the water-supply is drawn, remains unaffected by the temperature variation at the surface of the earth. It therefore appears relatively less cold to the touch compared with the lower surface temperature in the winter, but more cold compared with the higher surface temperature in the summer. The temperature of the waters of seepages and insignificant springs which obviously receive their supply from superficial sources generally varies with the surface temperature.

(e) Flow : The flow of the water has been measured. Invariably it is larger in the rains and early winter than in the summer, the variation being particularly noticeable in the case of the cold springs. In the case of the hot springs on the other hand a variation in the flow is not marked. But until the flow has been measured regularly through different seasons and even months of the year and the observations carried out over a number of years, a pronouncement cannot be made at this stage that the rate of flow does or does not fluctuate.

(f) Sources of the water : As stated already, the cold springs are of superficial origin, the ground water providing the source of supply. Some of the springs of this group which were bacteriologically examined proved

to be contaminated, presumably due to admixture with water of near-surface origin.

In the case of the hot springs however, several alternative hypotheses regarding their origin present themselves. The position has been discussed later. It will suffice to state here that further data are required for arriving at a definite conclusion on the matter.

2. RADIOACTIVITY OF THE SPRINGS.

Much stress has been laid lately on the influence of radio-activity on health. It is said that water of such low mineral concentration as that of Gastein, Bath *etc.*. owe their curative properties to radio-activity. The radioactivity of the waters is due to the presence of radon in solution, the radon being derived from the disintegration of the thorium and uranium bearing minerals present in the rocks through which the waters circulate. Most springs and even some well-water contain traces of radon, but very few contain radium salts in solution. Radon or radium-emanation is a chemically inert and highly soluble gas produced by the spontaneous decay of radium atoms. It is highly unstable and intensely active. So rapidly does it give up energy and liberate helium that its original activity decreases by half every four days, and is practically negligible at the end of a month.

Temporary Radio-Activity—Spring waters, except those which are permanently radio-active (due to the presence in them of dissolved radium salts) lose their natural radio-activity when bottled for any length of time and at the end of a month the radon disappears for all practical purposes. Such waters are called radio-emanative.

Permanent Radio-Activity—Permanently radio-active waters seem on the other hand to be very rare. In such waters radon is being constantly generated by the disintegration of the radium salts present in solution. The Indian springs investigated so far are radio-emanative, and are not permanently radio-active. Some springs in Bombay have been recorded as being permanently radio-active by Fathers Sierp and Steichen[15].

Pharmacology—Medical authorities are the best judges of the pharmacological action of radio-acitive waters. Judging by reports, it appears that generally speaking, radium emanation whether inhaled or taken in solution in mineral water is supposed to be a powerful stimulant of metabolism and as such it may be recommended for rheumatism of all forms, anaemia, weakness and gouty conditions, and probably also for skin conditions.

In order to ascertain the possible therapeutic values of the Indian waters, their radio-activity was determined by the "emanation method" in the field as well as in the laboratories of the Geological Survey of India. The radon values of some of the important Indian springs together with those of well-known European waters of comparable strength are furnished in table 2 (vide appendix).

3. CLASSIFICATION OF MINERAL WATERS.

Table Waters.

Between the so-called 'mineral waters' and waters of ordinary character, no sharp line of demarcation can be drawn. In fact, some of the springs having the greatest commercial importance yield waters with an average

mineral content of 500 parts to as low as 20 parts per million against that of about 100 parts per million in most large public supplies[5]. Such waters, because of their remarkable purity, are usually known as the Indifferent or Simple Waters. From the compositional point of view they are simply potable waters carrying a minimum of foreign matter in solution.

When free from any disagreeable taste, such waters are used as table and also for baths and are recommended for gout, rheumatism, certain forms of anaemia, digestive disorders and other internal complaints. There are several well-known foreign waters of this type, *e.g.*, Evian, Buxton, Schlangenbad, Wildbad, Warmbad, Warmbrunn, Sinnbergerquelle, Ludwigsquelle, Gastein, etc. Judging by the available analyses, foreign waters of this type have variable amounts of strong acid radicals : Chloride(Cl), Sulphate (SO_4) and of weak acid radicals, carbonate (CO_3) or Bi-carbonate (HCO_3) or both and silicic acid ($HSiO_3$). These radicals occur in different proportions, sometimes one being more dominant than the others. Similarly, among the basic radicals, the alkalis and the alkaline earths show variable proportions. Waters characterised by Alkalinity, chiefly Primary, and Primary Salinity[12] seem on the whole to be preferred to those showing high Secondary Salinity. Although it is difficult to find exact foreign equivalents of all the Indian 'Indefferent' or simple waters on the basis of comparison of the proportions of the individual radicals alone, quite a considerable similarity is detected when the comparison is based on the salinity and alkalinity data calculated on the basis of Chase Palmer's classification[12].

The majority of the Indian waters of this type are thermal, although a few cold springs also exist. Due to the presence of dissolved carbon dioxide, they are aften slightly acid in reaction. From the acid types, they range into the neutral and alkaline types and form a large group.

Medicinal Waters.

Many mineral waters contain enough soluble salts to give them a taste and such of them as have any therapeutical properties are regarded as medicinal waters. The chief active ingredients of these waters are the sulphates of magnesium and sodium, bicarbonates and chlorides of alkalis and alkaline earths. A few waters contain moderate quantities of some unusual constituents like iodide or bromide but all these waters are so concentrated in mineral matter that they cannot be taken in large quantities.

No hard and fast line can, however, be drawn between the medicinal and table waters as some of the former may have a lower content of mineral matter than 500 parts per million. Again some of the table waters, on continued use, may prove efficacious in certain ailments and may therefore be classed with medicinal waters.

A large number of springs showing a composition comparable to foreign medicinal spring water also occur in India as stated in the following section.

4. CHEMICAL ANALYSIS OF INDIAN MINERAL SPRING WATERS.

Comparison with Foreign Types.

As chemical properties impart a medicinal value to many spring waters, the Indian waters have also been examined from that point of view, and they may be used in the same way as the foreign types with which their composition bears a similarity.

The analyses are represented in the standard form, *viz.*, in terms of parts per million of the basic and acid radicals. The analytical data of the King Institute, Guindy and Mr. P. C. Roy of the Geological Survey of India, were available in this form except for some minor constituents expressed as oxides which have been recalculated as acidic or basic radicals as the case may be. The data of the Public Health Laboratory, Poona, Bombay, were expressed in the form of salts which have been recalculated in terms of bases and acids as required in the International Standard of Measurements.

Regarding the data used in comparison it should be understood that it is difficult, if not impossible, to find two or more waters containing exactly the same constituents which also occur in the same proportions. I have therefore aimed at showing the general similarity in chemical character, degree of mineralisation and the relative proportion of the various constituents.

In order to have an approximate idea of the amount of latitude that may be allowed in these comparisons, the corresponding figures of some of the American waters that are regarded as equivalents of the European ones may be helpful and are included in the tables wherever possible.

The Indian Waters fall into four main groups as indicated in the following classified list of representative spring waters the analyses of which are also furnished below.

(1) Simple or Indifferent waters of low mineral content, the total mineral content seldom exceeding 500 parts per million, and often as low as 40 parts per million. They are both cold and thermal.

COLD SPRINGS.

(a) Wildbad (Upper Bavaria)—Traunstein Type— PATALSUR and PARASHNATH (Hazaribagh District), KALDAM (Santhal Perganas District), Bihar.

(b) Evian Type—MOSSY FALL, Mussoorie, Dehra Dun District, United Provinces.

THERMAL SPRINGS.

(c) Acid Type— BRAHMMAKUND, the mineral composition of which is typical of many of the Rajgir group of springs, Bihar.

There are in addition neutral and slightly alkaline types of indifferent or simple water in India.

(2) Alkaline waters characterised by dominant soda and bicarbonate radicals. They are also both cold and thermal.

COLD SPRINGS.

(a) Appollinaris type—BRIDHKHAL WELL, Banaras, U.P.

(b) Wiesenbrunnens (Bad Salzburg) Type—GAIBI WELL, Banaras, U.P.

THERMAL SPRINGS.

(c) Mild Vichy Type (but with varying amounts of H_2S)—KAWA GANDHWANI, Hazaribagh District, Bihar. CHOTTA ANHONI, similar to Hoshangabad District, C.P., SOHNA, Gurgaon District, Punjab.

(3) Sulphur waters, characterised by the presence of H_2S and often the sulphide (S) and sulphate radicals. Both cold and thermal types have been recorded.

COLD SPRINGS.

(a) TRINKQUELLE (Bad Nenndorf) TYPE—SAHASRADHARA (Sansadhara) Dehra Dun District U.P.

THERMAL SPRINGS.

(b) Aix-les-Bains Type—DUARI and SURAJKUND, Hazaribagh District, Bihar.

(4) Chloride or saline water. The springs are thermal.

Marienquelle and Leamington Types—UNHERA (Kolaba District), UNHARA (Ratnagiri District), SURAJKUND, CHANDRAKUND, LACHMANKUND (VAJRESHWARI SPRINGS, Thana District), Bombay Presidency.

The analytical data, compared with foreign types where possible are supplied in the following pages.

1. INDIFFERENT OR SIMPLE WATERS (COLD)—WILDBAD (UPPER BAVARIA)

TRAUNSTEIN TYPE.

Name of spring	Patal Sur (Hazaribagh District, Bihar)	Parasnath (East of temple Parasnath Hill)	Kaldam Spring (Santhal Perganas, Bihar)	Wildbad, Upper Bavaria, Traunstein
Flow :	Temp : 27°C Variable, being 200 gallons per hour in April & 4000 gallons per hour in September.	Temp : 20°C Flow : 117 Gallons per hour in April, 1941	Tenmp : 25°C Flow : 100 Gallons per hour in April, 1941	
	Parts per Million.	*Parts per Million.*	*Parts per Million.*	*Parts per Million.*
Na'	18.00	9.00	28.0	15.0
K'	..	..	..	6.0
Mg'	3.60	..	4.2	7.0
Ca ''	11.80	8.60	22.9	21.0
Cl'	7.00	4.00	4.0	16.0
SO_4	Nil.	4.00	4.0	
HCO_3	46.00	45.00	127.0	
$HSiO_3$	66.73	20.53	148.86	121.0
Boron	(?)			
	153.13	91.13	338.96	186.0
Radon :	10.38 mMc	0.019 mMc	0.13	
PH Value	6.9	7.7	7.2	
Sp. Gr.	1.00020	1.00012	1.00030	
Bacteriological Examination :	Contaminated			

These are all cold springs, with nearly equal proportions of alkalis to bases, subordinate chloride and a little sulphate in addition. The higher value for radon in PATALSUR is noticeable. The flow is however liable to fluctuation, being considerably higher after the rains in September, than in the spring. The water was bacteriologically tested and found contaminated. It is evident, this spring receives a large part of its flow from surface or near-surface sources.

PARASHNATH and KALDAM are smaller springs, and the water is locally used for baths and drink.

The composition of these three waters is similar to that of the upper Bavarian Wildbad Spring, Traunstein, the water of which is used both for baths and drink and is recommended for gout, rheumatism, scorfula, catarrah of the lungs, nerve disorders, etc.

INDIFFERENT OF SIMPLE WATERS (COLD SPRING)

EVIAN WATER TYPE.

Indian Water		*European Water*
MOSSY FALL (Larger Spring) Mussoorie, Dehradun District, U.P.		EVIAN, France

Temp : 170°C ; Flow=800 gallons per hour.

Na	..	13.0	6.90
K	..	Tr.	2.30
Mg	..	12.2	23.70
Ca	..	50.6	78.40
Fe	..	..	..
Al	..	2.0	0.20
Cl	..	6.0	1.80
SO_4	..	156.0	8.50
CO_3	..	..	..
HCO_3	..	177.0	356.80
$HSiO_3$	..	12.06	18.22
Total Ions	..	428.86	496.82

Evian water is a well-known table water, and is beneficial in correcting metabolic disorder.

The Indian water, in addition to a high carbonate and bicarbonate content like the Evian type, shows a fairly high amount of sulphate. The water-supply of a local school is drawn from this spring.

INDIFFERENT WATERS (THERMAL)—ACID TYPE

Rajgir Spring : Patna, Bihar

BRAHMMAKUND

Temp :	42.5°C
Flow : Gallon/Hour	8,000

	Parts per million	Reacting value
Na	2.00	0.087
K	Nil	
Mg	Tr.	
Ca	11.40	0.570
Fe	Nil	
Al	Nil	
		0.657
(CL)	4.00	0.114
(SO_4)	Tr.	..
(HCO_3)	24.00	0.393
($HSiO_3$)	25.67	0.150
Total Ions	67.07	0.657
		Colloid :
PH Value	5.6	$HSiO_3$
Gases :	Intermittent bubbles of inert gases (?N)	0.18
Radon	6.1022	
	Percentage of Reacting value	
Alk :	6.6%	
Earths	43.4%	
Strong Acids	8.7%	
Weak Acids	41.3%	
	Character of water	
Primary Salinity	13.3	
Secondary Salinity	4.2	
Primary Alkalinity	Nil	
Secondary Alkalinity	82.6	

*Class III, Strong Acids higher than alkalis but less than total bases.

The Rajgir Springs which have been known for centuries are pilgrimage centres. The waters have a great therapeutic reputation and are used as baths and drink, and are said to be good for rheumatic complaints, gout, paralysis, osteo-arthritis, diabetes, dyspepsia and skin diseases.

***Chase' Palmer's classification (vide reference 12).**

2. ALKALINE WATERS (COLD)

(a) APOLLINARIS TYPE

	Indian springs	European	American
	Bridhkhal Well, Banaras, U.P.	Apollinaris water, Ahrweilor, Germany.	Maniton Table water, Maniton springs, Colorado.
	(In parts per million)		
Silica (SiO_2) ..	24	8	47
Iron (Fe) ..	0·65	20	1·8
Aluminium (Al) ..	0·80		
Calcium (Ca)	105·8	24	458
Magnesium (Mg) ..	137·6	127	79
Sodium (Na) ..	313·3	827	551
Potassium (K) ..	109·6	Trace	71
Carbonate (CO_3) ..	601·36	1061	1313
Bicarbonate (HCO_3) ..			
Sulphate (SO_4) ..	180·40	203	219
Chloride (Cl) ..	346·5	282	250
Total Ions ..	1,820·01	2,552	2,989·8
Gases :			
H_2S	Present		
CO_2	Present	Present	
Bacteriological Examination	Sterile		

Apollinaris water is used chiefly as aTable water and is very popular, several million bottles being sold per year.

ALKALINE WATER (COLD)

(b) "WIESENBRUNNENS" (BAD SALZBURG) TYPE

	Gaibi Well, Banaras, U.P.	Wiesenbrunnens, Bad Salzburg.
Na ..	92.51	127
K ..	14.90	..
Ca ..	30.01	85
Mg ..	40.90	12
Fe ..	0.50	6
Al ..	..	..
Cl ..	21.00	18
SO_4 ..	62.90	55
CO_3 ..	65.90	..
HCO_3 ..	426.10	569
SiO_2 ..	24.01	..
	778.73	872

Gases :
CO_2, H_2S

The German prototype is used both for drinking, bathing and is found efficacious in the treatment of liver trouble, gallstone, diabetes, etc.

ALKALINE WATERS (WARM)—BICARBONATE TYPE

Resembling mild Vichy water in general composition, H_2S being additional

---

BIHAR, HAZARIBAGH DISTRICT.

KAWA GANDHWANI—There are several vents; the water of Vents 1 and 4 have been analysed.

CENTRAL PROVINCES, HOSHANGABAD DISTRICT.

CHOTTA ANHONI

PUNJAB, GURGAON DISTRICT

SOHNA

In the following table, the analytical data are given. Attention is drawn to the similarity of these waters with Vichy water diluted 10 times.

(c) MILD VICHY TYPE

	Kawa Gandhwani, Hazaribagh Dist. Spring No. 1	Sp. No. 4	Sohna, Gurgaon Dist. Punjab.	Chota Anhoni, Hoshangabad C.P.	Vichy Water diluted 10 times.
Silica (SiO_2)	56	48.0	44	14	4.6
Iron (Fe)	Nil		Nil	0.7	Tr.
Aluminium (Al)	11.4	2.8	46.7		
Calcium (Ca)	Nil	2.8	11.4	16.7	7
Magnesium (Mg)	Nil	7.8	3.6		3
Sodium (Na)	109	92.0	123	188.9	97
Bicarbonate (HCO_3)	185	188.0	270	221.4	234
Sulphate (SO_4)	7	3.0	11	Nil.	11.3
Chloride (Cl)	39	36.0	199	59.0	18.2
Fluoride (F)	17	13.0	Nil	Nil	1.8
Total Ions	424.4	393.4	708.7	500.7	376.9
PH	7.4	7.6	7.3		
Sp. Gr.		1.00036			
H_2S / CO_2	Present	Present	Present	Present	

	1.	2.
Spectroscopical analyses indicate the presence of additional elements shown opposite. 1. Kawa Gandhwani. 2. Sohna.	Calcium, Potash, Manganese, Lithium, Barium, Strontium.	Iron, Manganese, strontium, Potassium, Palladium, Copper, Tin, Lithium, Zinc, Lead, Boron, Titanium, Molybdenum, Ruthenium, Platinum, Gold, Silver, Bismuth, Osmium, Beryllium, Iridium, Barium.
Bacteriological Examination —	Sterile	Polluted.

The table shows the presence of a number of constituents which may be of therapeutic importance. As already indicated they are both highly radio-active which property alone should make these waters sufficiently important.

Vichy water is used in diseases of the liver, convalescence from jaundice, gout, renal lithiasis, oxaluria, chronic rheumatism and gastric hyperacidity.

3. SULPHUR WATERS

SULPHUR WATER (COLD)

(a) Trinkquelle Type

	Indian	*European*	*American*
	SAHASRA DHARA (Sansadhara) (Dehra Dun Dt.)	Trinkquelle, at Bad Nenndorf (Germany)	White Sulphur Spring, New York.
Temp.	23°C (73.4°F)	..	..
	(In parts per million)		
Silica (SiO_2)	16	22.0	11
Iron (Fe), Aluminium (Al)	4	..	Trace
Calcium (Ca)	591.5	555	567
Magnesium (Mg)	12.3	129	108
Sodium (Na)	314.7	202	21
Potassium (K)	Nil.	21	13
Chloride (Cl)	5.0	189	5.7
Sulphate (SO_4)	1580	1485	1443
Carbonate (CO_3), Bicarbonate (HCO_3)	129	278	224
Sulphide (S)	15.1	34	13
Total Ions	2667.6	2915	2405.7
H_2S	Present	Present	Present
CO_2	Present		

Trinkquelle water is used for gout, rheumatism, psoriasis, dry eczema. neuralgia, chronic catarrah of the lungs, haemorrhoids, etc.

SULPHUR WATERS (WARM)

(a) AIX-LES-BAINS TYPE

	Indian	European**		American
	Duari, Hazari-bagh Dist. Bihar.	Surajkund. Hazaribagh Dt. Bihar	Aix-Les-Bains, France	Taylor Spring, California
Temperature	45°C (113°F)	87°C (188·6°F)		
Flow—Gallon per hour	500	3000		
	(In parts per million)			
Sodium (Na) ..	128	146	34	93
Potassium (K) ..	..	..	..	6·3
Magnesium (Mg) ..	Nil.	Trace	19	35
Calcium (Ca) ..	2·9	2·9	64	7
Iron (Fe) ..	Nil.	Nil.	4·2	Trace
Aluminium (Al) ..	4·24	Nil.	8·7	8·4
Carbonate (CO_2) ..	121	123	112	35·0
Bicarbonate (HCO_3) ..				
Sulphate (SO_4) ..	38	65	151	220
Sulphide (S) ..	20	..	34	13
Chloride (Cl) ..	71	92	18	59
Fluoride (F) ..	18*	21*	..	..
Silica Acid ($HSiO_3$) ..	87·26	164·26	6·40	25·60
Total Ions ..	490·40	614·16	451·3	502·3
Gases :—				
H_2S ..	Present	Present	Present	Present
CO_2 ..	?	Present	Present	Present
Radon ..	3·28	0·75		
The following additional elements have been detected by spectroscopic analysis.	Potash Manganese Lithium Strontium	Potash Lithium Strontium		
Bacteriological Examination :		Sterile		

* The high figures for fluorine indicate the necessity of inviting medical opinion as to the suitability of these waters for drinking purposes for over more than a limited period of time. This constituent should however have no deleterious effect in baths, sprays and other external applications for which the water may be found suitable. It may be of interest to note in this connection that a widely used water *viz*,. Vichy water has been reported to contain as much as 18 parts per million of fluorine.

** The waters are mildly aperient, induces appetite, and suitable for treatment of skin diseases, rheumatism, gout, liver and chronic malaria, etc. Surajkund waetr is alkaline and may be useful in correcting acidosis.

4. CHLORIDE OR SALINE WATERS—MARIENQUELLE AND LEAMINGTON TYPES.

	Indian						Foreign		
							European		*American*
	Unhera (Kolaba)	Unhara (Ratnagiri)	Surajkund, Vajreswari, Thana Dist.	Chandra-kund, Vaj-reswari, Thana Dt.	Spring 8. Vajreswari	Lachman-kund. Vajreswari, Thana Dt.	Leaming-ton.,	Marien-quelle	Arondack
Temp :	41.5°C	69°C	50°C	50°C	44°C	50°C			
Flow : Gallon per hour	400	1,500	600	260	60	700			
Sodium (Na) ..	409.1	669.4	710.1	492.5	492.8	270	714	982	827
Potassium (K) ..	..	..	..	..	..	..	..	..	..
Magnesium (Mg) ..	..	..	..	..	..	..	78.5	40	91
Calcium (Ca) ..	576.5	153.0	153.7	356.3	354.5	283	272.6	123	26
Iron (Fe) ..	0.8	3.0	..	..	..	..	4.2	2.7	..
Aluminium (Al) ..	..	..	..	..	..	148	..	..	..
Chloride (Cl) ..	1533.0	1090.9	1241.10	1254.2	1250.4	1207	1259.1	1566	1186
Sulphate (SO_4) ..	148.8	274.2	155.5	156.3	158.4	125	498.6	Tr.	504
Carbonate (CO_3) ..	6.4	8.0	9.2	.7.5	5.8	32	150.4	228	136
Bicarbonate (HCO_3) ..	..	..	..	..	..	..	..	..	..
Fluoride (F) ..	..	..	..	..	..	..	..	..	..
Silicate ($HSiO_3$) ..	5.1	5.1	6.42	15.785	13.60	112.93	32.965	?	11.80
Total Ions ..	2679.7	2203.6	2273.02	2282.585	2275.5	2177.93	3010	2941.7	2781.8
Gases :									
CO_2 ..	Copious	Copious	Copious	Copious	Copious	Copious			
H_2S. ..	Faint	Faint	Faint	Faint	Faint	Faint			

The Leamington and Marienquelle waters are definitely hypertonic, their physiological action being to produce evacuation of the bowel. The presence of calcium salt for which the waters are noted is of great value in re-mineralisation of the body, which is so necessary in all chornic and infective conditions. The water is also used with great success in cases of high blood pressure and certain cardiac conditions, particularly those due to metabolic disturbances.

The Indian waters do not contain magnesium salts, but the high proportion of sodium chloride may have an action on the bowels somewhat similar to the magnesium salt.

III. THE POSSIBILITY OF UTILISING SOME OF THE SPRINGS.

The foregoing account indicates that some of the Indian waters are comparable with some of the well known foreign types. There are others, *viz.*, the Indifferent or Simple type of water of Rajgir and Monghyr, which it has not been possible to match with foreign types. Nevertheless it is a fact that they enjoy a therapeutic reputation. To find out how they compare with the usual foreign types of water imported into India, we bottled them at the spring sites, making sure at first that they were free from harmful bacteria and that our bottles were sterile. The bottles were then sent out, I must admit not without a good deal of diffidence, to people in all walks of life in different parts of India with a request to give the samples a trial. In due course and to our pleasant surprise urgent requests were received from our clients and also from others who had heard about the waters, for further consignments. The opinions expressed by them were very encouraging. Some wrote even to say that the continued use of the waters had proved beneficial to their health. A similar response was met from the users of a medicinal type also.

Apart from the question of the waters having any intrinsic therapeutic value which only pharmacologists can judge after experimenting on patients under strictly controlled conditions, the fact emerged that the class of people who are regular users of table and medicinal waters were perfectly satisfied with the Indian waters. They also expressed the opinion that the waters were as good as any foreign water used by them. No statistics are available of the improt of foreign waters into India, nor of the amount of money spent by Indians on spa-treatment abroad. It is however understood that there is scope for running a mineral water industry successfully. The establishment of attractive and well-organised spa-resorts on the European and American model is sure to attract those who go abroad for the purpose and also others who for various reasons are unable to leave the country.

At one time, we had prepared an estimate for a bottling project dealing with 5 lakh bottles a year of a particular type of water, the estimate being as follows :—

Capital charges— Rs. 3.5 lakhs :

Annual working expenses—Rs. 54,000 per year.

Allowing for advertisements, interest on capital, depreciation, royalty, transport, etc., the profit including the middleman's, was estimated at As. -/3/- per bottle with the price of the water at As. -/10/- per bottle, the price being less than that of any foreign water sold in India.

As noted already, some of the waters are resorted to for baths and are popularly believed to be efficacious in certain ailments. The present arrangements for baths, etc., are very crude and unhygienic. There is even no accommodation where people can put up and roads are practically non-existent. The opening of the modern spa-indusrty in such places with hotels, amusement parks, etc., would not only benefit the industrialist and his clients, but would also open up the country to tourists and the general public who for lack of transport, accommodation and other facilities are unable to visit the beauty spots where the springs are situated. If properly run, I have no doubt such establishments would attract our celebrities and the hard worked men and women, important in public life who may be able to draw a fresh

supply of energy and freshness in course of a few days relaxation in such places.

The chief obstacle in the way of commercialising the suitable springs is the fact that most of them are either privalely owned or their ownership vested in religious bodies. Even so, these age-old objections are bound to disappear with a certain amount of educative propaganda. Times are changing fast and it may not be long before the owners concerned will wake up to the call of a progressive age.

Our work in introducing the springs to the attention of the public end here. Now it is for the medical man and the commercially minded to take up the enquiry where we left it.

IV. CONCLUSION

A statement on mineral springs would perhaps remain incomplete at least to geologists and geographers if the source of the water of the hot springs were not discussed.

In the case of the hot springs two factors are worth considering *viz.*, (1) the composition of the water, and (2) the constancy of the temperature.

It has been established that superheated steam forms over 95% of the volatile gases emanating from magmas; carbon dioxide forms nearly 2% and the remainder is composed of chlorine, fluorine and sulphur (as sulphide and H_2S) and occasional traces of boron and arsenic. Dealing with the region of the hot springs of Yellowstone Park, Day[4] comes to the conclusion that if the salts of these elements *viz.*, chlorides, fluorides, bicarbonates and smaller amounts of sulphates or sulphides, arsenates and borates which are normally absent or occur in very small quantity in the country rock are detected in the waters of hot springs, the participation of magmatic water is established.

The chemical and a few spectroscopical analyses of the waters of the Indian thermal springs demonstrate the presence of the characteristic components of juvenile waters with the exception of borates and arsenates, boron being detected in one water only. Further, Fenner's study of the bore-hole cores and the waters of the Yellowstone region has established the fact that the waters of the hot springs are rich in soda, while the juvenile water is rich in potash. The soda enrichment is brought about by the replacement of soda in the sodic minerals of the country rock by the potash of the juvenile water which in course of circulation through the country rock may lose almost all the potash. The juvenile water which is rich in silica is also responsible for the high value of silicic acid characteristic of the water of the hot springs. These two characters *viz.* (1) presence of high soda to the exclusion of potash and (2) high silica, are also common to the hot springs emerging in the Archaean terrain of India. In the Yellowstone Park Region, with other convergent evidence of the presence of a magma chamber within a short distance of the surface of the earth, such composition as the Indian thermal waters have, could no doubt be accepted as evidence of participation of juvenile water in the mineral spring activity.

Inspite of such striking resemblances in character one hesitates to ascribe magmatic influence to the water of the Bihar hot springs as there is no outward evidence of late magma activity anywhere in or in the neighbourhood of the Indian Peninsula with the exception perhaps of the Barren Island in the Andaman Sea and Koh-i-Sultàn in Baluchistan. So also there

is no outward manifestation of contemporaneous magmatic activity in Yellowstone Park, but as a result of observation in boreholes of the very rapid rate of increase of temperature downwards, it has been deduced that the parent magma which gave rise to the rhyolite intrusion in Pliocene times, is still maintained in a fluid state in a chamber fairly close to the surface.

Assuming that the energy of the Indian waters is associated with the still liquid remnant of the last phase of igneous activity, one has to go further in time than the Pliocene, *i.e.*, to the Deccan Trap period (Cretaceous to early Tertiary). Whether the traps may in depth still be in a fluid state and their juvenile water may still be available for the hot springs of the west coast of India and of the Central Provinces is worth looking into. In the case of the Bihar Archaean terrain, the problem is still more difficult. The latest exposed trap, *viz.*, the Rajmahal volcanics to the northeast of the Archaean tract of Bihar is generally believed to be Jurassic although its possible reationship with the Deccan Traps has also been hinted at. Is it possible that large injections of these traps not so far below the surface are still maintained in a liquid condition below the hot spring zone in Bihar? In the Gurgaon district in the Punjab and in the neighbouring portion of Rajputana, we know of no vulcanicity later than the Cuddapahs. It is a question if the hot springs of these areas should also be regarded as obtaining their energy from juvenile waters emanating from molten rocks underground.

On the hypothesis that the hot springs derive their energy from magmatic water it remains to be estimated what fraction the juvenile water forms of the total water feeding the springs. For the juvenile water on its way up must discharge itself into the permanent ground water reservoir so that the water as it emerges at the spring results from the commingling of magmatic and vadose waters. We may get a clue to this problem from the temperature of the water of the spring. The work of Allen and Day[4] in the Yellowstone Park has shown that the amoumt of magmatic water (superheated steam) required to raise ground water to the boiling point of water would vary between 13·4%—12·7% assuming the temperature of the superheated steam ranges between 138°C—238°C. On this basis a proportionately lower percentage of juvenile water would be required to account for the comparatively lower temperature observed at the springs.

The fact that a constant temperature is maintained show that the commingling of the two waters, magmatic amd meteoric must take place at some depth below the ground water level where the quantity of the surface water is fairly constant being dependent on the pore space, cracks and crevices of the bed -rock and the mean annual rain fall, but independent of the fluctuation of precipitation.

In the case of the hot springs of Yellowstone Park, Day and Allen have with good reason departed from the earlier conclusion of Hague that "The vadose ascending waters do not appear to have been greatly affected by any primitive deep-seated waters or their contents". Their conclusions that (1) the hot springs of Yellowstone Park derive their water from the permanent ground-water zone into which magmatic emanations are discharging their contents, (2) the magmatic emanations form about 13 p.c. of the total water and (3) the rhyolite magma which extruded in Pliocene times is still providing the magmatic emanations from its still fluid core in depth, are based on a considerable amount of research on the composition of the waters, measurements of the rate of flow of the water and also on the results of examination of the berehole cores and the measurements of the temper-

ature gradient. Intensive research on such an elaborate scale was not possible in our case, nor was it called for by the limited nature of the enquiry.

An examination of the data afforded by the composition and constancy of temperature of the waters in the light of the researches in Yellowstone Park leads to the postulation of a magma the extrusion of which took place in the Deccan Trap period or even earlier. Or one may even speculate that unknown to the geolosist a mass of molten magma has lately risen from the depths under the superficial skin of the crystalline rocks. Is there any relationship between the hot springs and this underground pile of sub-crustal volcanic material ?

There may be another alternative to the postulated under-ground magma column. Gautier showed that 1 cubic-kilometer of granite can yield from 25 to 30 millions of metric tons of water which at 1,100°C would form 160,000,000,000 cubic meters of steam. In addition to this enormous volume of vapour 28,000,000,000 cubic meters of other gases would be emitted. If by fissuring and subsidence in the lithosphere such a mass of rock were carried to a depth of 25,000 to 30,000 meters it would then be in the heated region, and the evolution of vapours under great pressure would occur. Ordinary thermal springs may be formed by the same process, operating perhaps less violently and originate, so to speak, from a sort of distillation of the combined water contained in the depressed masses of rock[3]. Presumably such a hypothesis would demand the foundering of a large block of the country rock in late geological times, and the instability of the country The fissures along which the springs are situated may have orginated at this period, following the general lines of weakness in the earth's crust set up in the Gondwana times. We cannot however detect any geological evidences of such large scale foundering of the earth's crust in the Peninsula since the Gondwana times. But to the north of the tract is the Indo-Gangetic trough, the lowering of which in the depths of the earth may still be taking place. Mr. A. M. N. Ghosh has asked me to consider if the depressed mass of sial beneath the Indo-Gangetic trough may not be undergoing such "distillation" and providing through some channels. the requisite quantity of water to the hot springs of the terrain immediately to the south. It is a bold speculation, but there may be something in it.

There is a third alternative regarding the source of the heat, *viz.*, the higher temperature of the deeper parts of the crust. As the vadose water descends sufficiently deep down in the interior of the earth the temperature of which increases with depth roughly in the ratio of 1°C for every 31.7 meters of depth or 50°C per 1 mile, the water is warmed up and when it is driven upwards, it emerges as a hot spring at a correspondingly high temperature. Allowing for the loss of heat sustained by the heated water in passing upwards through the colder regions of the earth and meeting colder meteoric waters on the way, it is not unlikely that on this assumption the water of the hottest springs of Bihar are possibly issuing from depths of well over five to ten miles. The depth may be even greater if the temperature gradient be anything of the same order as that observed in the Kolar Gold Field, *viz.*, about 1°C *per* 207 ft. However, even allowing for the chemical characters, *viz.*, the large development of Na, F., S, HCO_3, etc., it seems doubtful if large quantities of meteoric water could penetrate to such depths which must reach below the zone of cementation or below the base of the zone of the ground water.

A fourth source of heat seems to be available in the exothermic reaction of certain chemical and mineral transformations, *viz.*, in the disintegration of radio-active elements and the decomposition of pyrite in the generation of H_2S which characterises many of these springs. The amount of heat generated in this way however cannot appreciably add to the heat of the water, or it cannot be the universal cause of the heat as some of the strongly sulphuretted and radio emanative waters are known to be cold. In any case at the present stage of our knowledge, there is no justification for ascribing to them any important part in supplying energy to the hot springs as such minerals are present only in traces in the rocks in question.

Although no direct data are forthcoming to answer the question of origin of the water satisfactorily, the balance of evidence seems to favour the hypothesis that the source of the heat must be somehow connected with the juvenile waters released by a magma chamber hidden below the surface. To prove the deduction with any degree of certainty, the necessity is indicated of a few boreholes in selected regions. A more rapid rate of increase of temperature than usual (50°C for one mile) in these boreholes or the appearance of special features in the bore-hole cores or in the waters in depths may yield some definite answer to our problem. I have no doubt the public who have so often responded generously to the cause of education and other noble efforts will consider these suggestion when they are looking for a deserving cause in which to invest their money. And I hope I shall not be misunderstood by the non-geologists among them, were I to reassure them, if indeed such assurance be called for, that the subterranean magma even if proved woule hardly get to the stage of becoming a source of inconvenience to them or their posterity for as far forward in the future as they care to look

Such are the geological and geographical aspects of the problem of hot springs, and you will see at once how much remains to be done or if a reasonably accurate answer to all our questions will ever be forthcoming.

V. Reference

1. Buist, G.—Notes on the Hot Springs of India ; *Trans. Bom. Geogr. Soc.*, X, Proc. xliii—xlv (1851).
2. Chatterjee, N. K.—The Radio-activity of the Thermal Springs of Rajgir ; *Indian Medical Gazette*, LXXI, pp. 150—153, (1936).
3. Clarke, F. W.—The Data of Geochemistry (3rd Edition, 1916), p. 214.
4. Day, A. L.—The Hot Spring Problem ; *Bull. Geol. Soc. America*, 50, pp. 317—336, (1939).
5. Ellis, A. J. & Chambers, A. A.—Mineral Waters in 1916 ; *Min. Res. U.S.*, 1916, Pt. II, pp. 463—510, (1918).
6. Holland, Sir T. H.—Review of the Mineral Production of India, during the years 1898-1903, Mineral Waters, *Rec. G.S.I.*, Vol. XXXII, Pt-1, pp. 111—112, (1905).
7. La Touche, T. H. D.—A Bibliography of Indian Geology and Phy. Geography, Pt. 1-B. An Annotated Index of Minerals of Economic Value, pp. 372—388.
8. Macpherson, Dr. J.—Table of Mineral Springs in British India with a few remarks ; *Ind. Ann. Med. Sci.*, II, pp. 205—221, (1855).

9. Nag, N. C.—Investigations on the Radio-activity of Hot Springs at Rajgir ; *Transactions of the Bose Institute,* Vol. VII, p. 319, (1931-32).

10. Newbold, Capt. T. J.—On the Thermal Springs of Calwa & Mahanadi in the Kurnool Province ; *Mad. Journ. Lit. Sci.,* XV, pp. 160-162, (1848).

11. Oldham, T. & R. D.—The Thermal Springs of India, *Mem. G.S.I.*, Vol. XIX, pp. 99—161, (1882).

12. Palmer, Chase—Geophysical Interpretation of Water Analysis *Bull. U.S.G.S.*, 479, pp. 5—31, (1911).

13. Ray, Dr. K. S.—Mineral Waters of India : *Journ. Ind. Med. Assn.*, Vol. I, No. 6, pp. 221—227, (1932).

14. Schlagintweit, Robert.—Enumeration of the Hot Springs of India & High Asia, *Journ. A.* S. B., XXXIII, pp. 49—56, (1862).

15. Sierp, Rev. H ; Steichen, Rev. Dr. A.—Radio-activity of some Thermal Springs in the Bombay Presidency ; *Indian Medical Gazette*, pp. 457—463, (1911).

16. Sierp, Rev. H.—On the Radio-activity of some Springs in the, Bombay Presidency and Baluchistan ; *Indian Medical Gazette* XLVIII, pp. 259—263, (1913).

17. Steichen, Rev. Dr. A.—The Radio-activity of some Wells and Thermal Springs in the Bombay Presidency and in the Baropa State ; *Indian Medical Gazette*, XLVII, pp. 469—474, (1912).

APPENDIX—Table II.

TABLE SHOWING RADON CONTENT OF SOME OF THE INDIAN MINERAL SPRINGS COMPARED WITH THAT OF WELL-KNOWN FOREIGN SPRING WATER

I. VERY STRONGLY RADIO-ACTIVE.

EUROPEON WATERS	RADON CONTENT IN m Mc.
Caria, Portugal	(46 ·46—5 ·10)
Bad Gastein, Austria	(Same as above)
Roman Well, Isle of Ischia, Italy	(11 ·2112)
Joachimsthal Spring	(5 ·096)
(Used solely for their radio-activity : said to cure rheumatism of all forms, anæmia, weakness and gouty conditions)	

INDIAN WATERS	RADON CONTENT IN m Mc.
Jarom, Palamau District, Bihar	17 ·7
Patalsur, Hazaribagh District, Bihar	10 ·38
Kawa Gandhwani Springs, Hazaribagh District, Bihar	8 ·56—8 ·38
Rameswar Kund, Monghyr District, Bihar ..	7 ·85
Usir (Seepage), Manbhum District, Bihar ..	7 ·78
Brahmakund, Patna District, Bihar .. .. Chandramakund, Surjkund, Sitakund, Patna District, Bihar	6 ·8713—6 ·20
Brahmakund (Tapoban), Gaya District, Bihar ..	6 ·1022

II. STRONGLY RADIO-ACTIVE.

EUROPEON WATERS	RADON CONTENT IN m Mc.
Grabenbacker Spring	(4 ·368—1 ·456)
Buttel, Baden Spring	(3 ·276—3 ·64)
Porla, Sweden Spring	(2 ·912)
(Used solely for their radio-activity ; said to cure rheumatism of all forms, anaemia, weakness and gouty conditions).	

INDIAN WATERS	RADON CONTENT IN m Mc.
Rishikund Springs (Gr.I), Monghyr District, Bihar ..	5 ·06—3 ·56
Agnikund, Gaya District, Bihar	4 ·234
Makdum Kund, Jamuna Kund, Ganga Kund, Vyas Kund, Patna District, Bihar	4 ·13—3 ·576
Shringirikh, Monghyr District, Bihar	3 ·052—3 ·08
Sita Kund, Monghyr District, Bihar	3 ·05—4 ·21
Phillipskund, Monghyr District, Bihar	3 ·046
Duari, Hazaribagh District, Bihar	3 ·00
Sohna, Gurgaon District, Punjab	2 ·93
Agnikund (Bakreswar), Birbhum District, West Bengal	2 ·80

III. MILDLY RADIO-ACTIVE.

European Waters.	Radon content in m Mc.
Hog, Sweden	(2·184— 1·82)
Bath	(1·73)
Apollinaris	(1·376)
Buxton	(1·20)

(Uses :—Utilised because of their radio-activity as well as medicinal constituents).

Indian Waters.	Radon content in m Mc.
Rampur (West of Jiajori), Santhal Pargs., Bihar ..	2.197
Tanteswari Santhal Pargs., Bihar	2.06
Markandya Kund, Patna District, Bihar	1.73
Surajkund, Hazaribagh District, Bihar	1.41—1.39
Viswamitra Kund, Patna District, Bihar ..	1.38
Charak (West and East), Manbhum District, Bihar ..	1.15—0.62
Ram Kund (Hot Spout), Patna District, Bihar ..	1.0035

IV. FEEBLY RADIO-ACTIVE.

European Waters.	Radon content in m Mc.
Harkany	(0.36)
Droitwitch	(0.21)

(Uses :—Utilised chiefly for medicinal constituents)

Indian Waters.	Radon content in m Mc.
Lachmiswarkund, Monghyr District, Bihar ..	0.98
Barhmasia, Santhal Parganas, Bihar ..	0.92
Unhara, Ratnagiri District, Bombay ..	0.806
Brahmakund (Bakreswar) Birbhum District, West Bengal	0.79
Chandra Kund, Thana District, Bombay ..	0.585
Bridhkal, Banaras, U.P.	0.5255
Mossy Fall (Larger) Mussoorie, Dehra Dun District, U.P.	0.4965
Lachman Kund No. 1, Thana District, Bombay ..	0.424
Lake, 1 mile South of Sitakund, Monghry District, Bihar	0.308
Sahasra Dhara Dehra. Dun Dt., U.P.	0.273
Gaibi, Banaras, U.P.	0.25
Tatloi (On Damodar), Springs 1, 2, & 3, Manbhum Dist. Bihar	0.24, 0.12, 0.07
Victoria Park Tube-well, Golbagh Tube-Well, Bharatpur State	0.19—0.18
Tantloi, Santhal Pargana, Bihar	0.14
Kothawala's Spring, Thana Dist. Bombay ..	0.066
Parasnath Hill, Spring east of Temple, Hazaribagh Dist. Bihar	0.02
Trikut pahar, Santhal Parganas, Bihar ..	0.018
Rajapur (Unhala), Ratnagiri Dist. Bombay ..	Trace.
Ram Kund (Cold Spout), Patna Dist. Bihar ..	Trace.

SECTION OF PHYSIOLOGY

President :— Dr. Bashir Ahmad, M.Sc., Ph.D., F.N.I., etc.

PRESIDENTIAL ADDRESS

THE PLACE OF BIOCHEMISTRY IN INDIA

I am highly grateful for this honour which the Indian Science Congress has conferred upon me by electing me to preside at the Physiology Section of the thirty-fifth session of the Congress. Indeed I value this great honour all the more profoundly, since I regard it as a mark of recognisation of the importance of biochemistry in a country where so far this dynamic branch of science has received scant attention. I feel very much grieved and disappointed, however that political events in this country prevent me from being present today in body, though I am with you in spirit. I pray that science which knows no national or communal boundaries, will help to put an end to this temporary insanity and bring together all scientists on this subcontinent to work hand in hand and shoulder to shoulder for the good of mankind as a whole.

For my address today I propose to speak on the importance of a branch of science, for which, to win its rightful place in this country, I and my fellow biochemists have fought a losing battle for many years. It is a curious fact that this young and most rapidly growing branch of science which has made contributions of far reaching importance in less than two decades for the welfare of man in many fields particularly in medicine, public health, agriculture, industry and towards the solution of social problems, should receive so little consideration in this country. Only two out of the twenty-one great seats of learning in this land have attempted to establish any departments of biochemistry. Even of these two only one has a full chair in this subject, while in the other it has not progressed beyond a lecturership. In all except one, of the many medical, agricultural and general scientific institutions of the land where this important

branch of science could play a worthy role, it is allotted a back and neglected bench. It is not necessary to analyse the causes which have gone to help in this state of affairs. It may be even far fetched to imagine that ignorance and jealousy played a part, but curiously enough the fact remains that positive support in this struggle came not from any devotees of chemistry or medicine or agriculture, subjects with which biochemistry has intimate relationship, but from some eminent physicists whose love of science prompted them to uphold its rightful cause. One of these through his wide vision and his able editorship of Science and Culture has done a great deal for this branch of science. Biochemistry in this country owes Professor M. N. Saha a great debt of gratitude for his support for its promotion and development.

In this address it is my desire to draw attention to some of the important contributions of biochemistry in the advancement of the various sciences concerned with problems of human welfare, and indicate some of the future possibilities, in the hope that it will help to win a rightful place for this branch of knowledge in the scientific institutions of this country. I shall begin with chemistry.

Every student of this science knows what tremendous amount of literature has been produced during the last two decades on the subjects of vitamins, hormones and enzymes. For many years on each one of these subjects over a thousand papers have been published annually in the various scientific journals of the world. Indeed it would have been impossible for any individual scientist to keep abreast of such rapidly advancing knowledge, but for the invaluable service of the authors and editors of the Annual Reviews of Biochemistry[1] who deserve the highest tribute. This flood of literature is indicative of the fruitfulness of these fields of research and the immediate importance of the applications of the discovery of new facts. The discovery of vitamins resulted from observation on certain ancient diseases, but the isolation of the chemical entities whose deficiency in the dietary was responsible for the syndrome involved the use of techniques and the processing of the quantity of materials hitherto unknown in the chemical laboratory. Since the active substance was present to the extent of a few parts per million of the natural material, almost tons of the material had to be worked up to obtain a few milligrams of the active substance. The difficult, complex, and time-consuming schemes of fractionation and purifica-

tion had to be devised. The cost involved has been tremendous. The isolation of the first gram of thiamin cost almost fifty lacs of rupees[2]. To obtain one gram of biotin, 360 tons of yeast were required[3] and even if one were to obtain it from eggs which contain ten times as much biotin as yeast, the cost of eggs alone will be in the neighbourhood of 7,00,000 rupees. Nevertheless the evolving of new techniques alone have enriched chemistry to such an extent as to justify this tremendous expenditure of funds.

Further still new techniques were evolved in the determination of the structure of vitamins. Micro-methods were often developed and applied. Means were found to dispense with the essential conditions of purity before embarking upon structural studies. Karrer worked with a rich concentrate of vitamin A for the determination of its structure. Williams and his colleagues[4] conducted successful structure studies on a prepartion of calcium pantothenate which was only about 90 per cent pure. Folkers[5] has summarized the unique series of studies which have led to the establishment of structure under conditions when the substance was both impure as well as available only in micro quantities.

The role of vitamins in the alleviation of disease, and the eradication of such plagues as beri-beri, scurvy, pellagra, which took an enormous toll of life in many parts of this earth, was important enough to justify the support which this study obtained in different laboratories of the world. The biological significance of these chemical substances went, however, much further. Many conditions of obscure aetiology, and in apparently normal individuals, a feeling of vague illness, proved to be due to a deficiency of one or the other vitamin, and yielded readily to vitamin therapy. Thus vitamin therapy became popular for the promotion of optimum health with considerable success. Further still the science of nutrition which developed rapidly under the stimulus provided by the study of vitamins, raised important political and social issues. It was recognised that one of the important functions of a democratic state was to provide adequate nutrition to all groups of its population. This recognition in turn produced repurcussions in agriculture, industry, and other fields. For the large scale fortification of flour and bread with vitamins, the chemical industry improved technique of synthesis, and developed methods of large-scale production. The result was that vitamins which were earlier available in the laboratory in

quantities of milligrams only appeared on the market in pounds and the production of some of the major vitamins reached a figure of 100,000 to 1,000,000 lbs. a year. Vitamins became a part of the big business. Large advertising campaigns were instituted for the use of vitamins and as profits increased more money flowed back into research. Today grants of $50,000 a year for nutrition research to individual biochemical laboratories in the United States is not uncommon.

Coming to the subject of hormones, this field has not lagged behind that of vitamins, in the prolificity of literature, the importance of its discoveries and their application to human problems. In fact the output of papers has been so prolific in this field that new journals were founded to publish researches in endocrinology. Taking the group of sex hormones alone, it is well known how the biochemistry of these developed with almost explosive rapidity after the isolation of Oestrone by Doisy[6] and by Butenandt[7] in 1929 from human pregnancy urine. In less than a decade the entire group of naturally occurring oestrogenic and androgenic compounds, and progesterones were isolated, their chemical structure and the laboratory synthesis of some of them worked out. The physiological action of these compounds, their biosynthesis, their metabolism and their role in pregnancy, reproduction, lactation, growth, puberty, sinility are subjects of profound human interest and biochemistry has enriched our knowledge of these remarkably. Researches on hormones have also led to the discovery of new techniques both in chemistry and clinical medicine. In the latter field the nature of sex determination, sex involution, pubertal growth have been delineated exprimentally with the help of these hormones.

The possibility of cholesterol being the starting point of the biosynthesis of steroid hormones was indicated by Fieser[8] and by Koch[9] in their admirable monographs. Recent studies of Bloch with the help of deuterium containing cholesterol have provided an experimental support for this view. The administration of this cholesterol, led to the appearance of deuterium containing pregnandiol in pregnancy urine. The output was of the order expected. Discoveries of fundamental importance are likely to result from a study of the role of hormones in cell processes which are being actively pursued today. The action of androgens in the synthesis of proteins, and of adrenal cortex steroids in the metabolism of carbohydrates, proteins and salts are already well-established.

Enzymes is another fruitful field which biochemistry has explored with admirable success. While the foundations of this study were laid almost in the middle of the last century by the work of Liebig and Pasteur on fermentation, it is only during the last two decades that we have been able to get a clearer glimpse of the myriads of chemical reactions taking place in the tiny living cell. These chemical reactions which are collectively referred to as intermediary metabolism and whose integrated systems are responsible for all the phenomena of life, are not spontaneous, but organised and well controlled processes brought about by highly specialised catalysts, the enzymes. Since the number of chemical reactions in a tiny living cell are to be counted in hundreds it supposes the presence of hundreds of enzymes. This, in fact is true and literally hundreds of enzymes have been isolated from the small yeast cell. The fundamental importance of enzyme studies is evident from the single fact that a Nobel Prize has come to most of those who have taken a hand in this remarkable work. I shall recount some of the names; Eduard Buchner (1907), Otto Meyerhoff (1922), Hienrich Wieland (1927), Arthur Harden (1929), Hans Von Euler (1929), Otto Warbugg (1931), Albert Szent Gyorgyi (1937) and lastly Richard Kuhn (1939) whom the Nazi decree did not permit the acceptance of the prize.

One of the most remarkable achievements of biochemistry in the field enzymes, is the reconstruction of the entire process of the fermentation of glucose to alcohol and glucose to lactic acid *in vitro*. Some 20 enzymes are involved which have been isolated and prepared in a pure state. A complete picture has been produced of the chemical details of how the various enzymes systems are linked and how the different chemical reactions are synchronized. This indeed is a remarkable achievement, but it is a drop in the ocean. Vast fields of virgin territory remain unexplored in enzyme chemistry.

Some other land marks in the field of enzymes are the elucidation of the chemical nature of cozymase by Euler and his school (1937); of cocarboxylase by Lohman and Schuster (1937); of the yellow enzyme of Warburg by Warburg himself and by Kuhn (1935) and Karrer (1935); of the enzyme of tyrosine decarboxylase by Gunsalus (1944), all of which are examples of vitamins functioning as prosthetic groups. These explain the organism's continuous requirement of vitamins. Similarly the indispensability of certain trace

elements in nutrition point to their being parts of some important enzyme systems. The development of the knowledge of enzyme chemistry also provides a basis for the understanding of the chemotherapeutic action of drugs. Observations on the relation of sulphonamides and *p*-amino-benzoic acid are an important milestone in this direction. These supports the view that sulphonamides only compete with *p*-amino-benzoic acid in the formation of an essential enzyme complex. The action is not unlike an antivitamin. For the first time these studies open up an important avenue for a rational programme of chemotherapeutic research after many decades of much wasteful effort in trial and error organic synthesis.

These few facts are enough to indicate the enormous quota of the contributions of biochemistry in the fields of vitamins, hormones and enzymes and their application in medicine. Even in day to day diagnosis and treatment of disease, the help of the biochemist is becoming increasingly important. Very often his findings are essential for arriving at a correct diagnosis. Some of the micro-methods developed and used by him represent advances of great significance in chemical methodology. The techniques developed by Folin and wu (1919) and Bang (1916) for blood analyses ; capillary colorimetry developed by Richards, and procedures of Linderstrom-Lang for investigations of enzymes in cells, are land marks in quantitative analytical chemistry.

Lately biochemistry has come to play an increasing role in agriculture. Agriculture today is not only concerned with increasing yields but quality is an important consideration. For food crops the production of total protein, total carbohydrate or total vitamins are considered more appropriate criteria than merely total weight. Indeed biochemical studies go much further and enquire into the quantity of a particular essential amino-acid, or any vitamin or enzyme which a particular crop would yield. The relative influence of climate, seasons, latitude, altitude, fertilizers, and soil conditions has been studied, and results of striking value obtained. A few years ago we investigated the thiamin content of different varieties of wheat grown in the Punjab and found values ranging from 2 to 6 μg per g, indicating that certain varieties under certain conditions of growth produce three times as much thiamin as the variety with the lowest value. The importance of these observations is obvious.

Fundamental knowledge of plant biochemistry is essential to

the plant pathologist, the plant geneticist, the horticulturist and the economic botanist. This knowledge has grown into an important branch, though not as far developed as animal or bacterial biochemistry. The course of biochemical reactions in the plant are somewhat more complex than in the aniaml. Starting from carbon dioxide, water and a few inorganic elements, the plant cells synthesise an extraordinary range of complex organic compounds providing complete systems of synthesis and break down within themselves. Plant tissues, unfortunately do not offer the same facilities for study, as the blood, the glands, the liver, or the organs of digestion and excretion in the animal, but new techniques for investigating the complex biochemical systems of plants are being devised which open up avenues of enormous possibilities. For example an enzyme system has been isolated from plants by the help of which starch can be synthesized *in vitro.*[10,11] Even the enzymic synthesis of sucrose has been accomplished *in vitro.* Though the starting materials in this case were glucose-monophosphate, fructose and an enzyme system obtained from a bacterial organism, a line of attack has been opened which offers possibilities of development.

There are many other important fields in which biochemistry is making contributions of fundamental importance. Mention may be made of genetics, viruses, chemotherapy and immunology. An insight is being gained into the nature of genes and viruses, and how they direct biochemical reactions leading to profound effects. The mechanism of the genetic control of the oxidation of homogentisic acid presumably through a specific enzyme ; of the synthesis of plant pigments such as carotinoids, anthocyanins and flavones ; and several other oxidations and syntheses in the plant and in the animal, is being gradually elucidated. Recent observations on the chemical and genetic mechanism of the reproductive system of *Chlamydomonas*, and of the amino acid synthesis in *Neurospora* are of great significance. Encouraging investigation have been made on the chemical nature of viruses, and change of their chemical structure by certain chemical reactions. A clearer understanding of the biochemical mechanism of the therapeutic action of drugs is being reached. Chemical nature of the protein antigens and specific polysaccharides, of toxin and antitoxin reactions is being revealed and foundations of the science of immunochemistry laid.

I have picked up and presented to you a few glittering fragments from the large mass of scientific literature in biochemistry and

indicated the role which they play in the progress and welfare of man. Biochemistry today is no longer the hand-maid of medicine, or the ugly duckling of Physiology. It is a full grown science in its own right. Though still young, it has grown in stature bigger than some of the traditional branches. Give biochemistry a chance in your chemistry laboratories, in medical and agricultural institutions and in industrial laboratories. It has already done tremendous service to man, but its unexplored potentialities are even greater. Therefore the years that lie ahead are exciting ones. By neglecting this important branch of science are we going to deprive ourselves of a share in a development, which may affect the future destiny of every living being in this world.

REFERENCES

1. *Annual Reviews of Biochemistry*, Edited by James Murray Luck, California University Press.

2. Williams, R.R. (1942) *Science*, 95,335.

3. Kogl F. (1938) *J. Soc. Chem. Ind.* 57,49.

4. Williams, R.J. *et al* (1938) *J. Amer. Chem. Soc.* 602,719.

5. Folkers, K. (1946) *Currents in Biochemical Research*, edited by David E. Green. P. 92.

6. Doisy *et al* (1929) *Amer. J. Physiol.* 90,329.

7. Butenandt (1929) *Naturwissenschaften*, 17,879.

8. Fieser, L.F. " *The chemistry of natural products related to phenanthrene* " New York (1937).

9. Koch, F.C., *Sex and internal Secretions*. Baltimore (1939).

10. Hanes, C.S., (1940) *Proc. Roy. Soc. London*, B 128,1421 ; B 129,174.

11. Haworth, W.N. *et al* (1944) *Nature* 154,236.

THIRTY-FIFTH SESSION

INDIAN SCIENCE CONGRESS

PATNA, 1948

CHEMISTRY SECTION

President : DR. B. SANJIVA RAO, M.A., PH.D., D.SC. (LOND.), F.N.I.

PRESIDENTIAL ADDRESS

(*January*, 1948)

RICE

Physico-Chemical Aspects of its Curing to Secure Vitamin Conservation and Improvement in Storage and Cooking Quality

It is but appropriate that at a session of the Indian Science Congress, held at Patna, there should be an address on certain aspects of the chemistry and technology of rice, for Patna has long been famous as a centre of the rice industry.

Though rice is the staple food of nearly half the world's population, its technology has not received until recently, proper attention. Owing to the acute world shortage of rice, however, and the consequent necessity for getting the best out of limited supplies, increasing attention is now being paid to the technology of rice. This address deals with such investigations.

The number of named varieties of rice is said to exceed two thousand. Hundreds of varieties are cultivated. There exist between these varieties marked differences in quality as revealed by consumers' preferences. Attempts have been made to correlate quality in rice with certain chemical and physico-chemical properties of the cereal. Hooper (*Agri. Ledger*, 1908, **5**, 63) analysed 159 samples of various Indian rices and noticed that the variations in chemical composition could not be correlated with quality. Warth and Darabsett (*Pusa Bulletin No.* 38, 1914) attempted to use the action of alkali on the rice grain as the basis for determining quality. Steinbarger (*Cereal Chem.*, 1932, **9**, 317) tested the cooking quality of certain domestic varieties. A biochemical study of certain aspects of quality in rice was carried out by Sahasrabuddhe and Kibe (*Indian J. Agri. Sci.*, 1935, **5**, 12). Extensive investigations were carried out at the Central College,

Bangalore, to correlate varietal differences in physical properties with the quality of rice. A study of sorption and desorption of water by rice grains showed that in general, superior varieties of rice lose water more readily during dehydration, and take up water at a faster rate, during hydration. than varieties of poorer quality (Subbaramiah, K., and Sanjiva Rao, B., *Proc. Ind. Acad. Sci.*, 1937, 6, 36). This showed greater permeability of the grain to moisture in superior varieties. Changes in electrical conductivities of rice suspensions in water, at different temperatures, were studied. Varietal differences in the rate of increase of conductivity were observed, but could not be correlated with quality (Subbaramiah and Sanjiva Rao, *Proc. Ind. Acad. Sci.*, 1937, **6**, 52). The question whether there was any difference in the hydrophilic character of raw starch from different varieties, was examined by determining gold numbers and congorubin numbers of rice suspensions in water. It was found that the gold numbers were not reproducible. The congorubin numbers, however, were reproducible; but no significant variations were noticed between different varieties of rice (Subbaramiah and Sanjiva Rao, *Proc. Ind. Acad. Sci.*, 1937, **6**, 46)' Calorimetric work on the hydration of rice gave interesting results. While a little heat developed on wetting rice grains with water below 40° C., hydration of rice was an endothermic process. The absorption of heat was found to be closely associated with the swelling of the grains on hydration (M. R. A. Rao and Sanjiva Rao, *Symposium on Colloids*: *Ind. Acad. of Sci.* 1935).

SWELLING OF RICE

This observation led to an extensive investigation of the swelling of rice grains when cooked. It was found that there was a close correlation between the quality of rice (as indicated by consumers' preference) and the swelling of rice when cooked, under certain standard conditions (Sanjiva Rao, 10*th International Congr. Chem.*, 1939, **4**, 550). This correlation furnished a convenient method of determining cooking quality, and of expressing it in quantitative terms by "Swelling Numbers". The swelling number (S.N.) of a rice is the weight of water imbibed by 100 g. of rice when cooked in water for 30 minutes at 97° C., under certain standard conditions. This simple method of determining cooking quality has been in use at the Central College for over ten years and has been found to give highly reproducible results.

Useful information about the cooking quality of rice was obtained by a study of swelling numbers. It was found that rice from freshly harvested paddy had a low value of 96 for its S.N. The value however rose to 234 when the paddy was cured by heating at 60° C. in a sealed tube, for six hours. Water was liberated during the heat treatment. When the paddy was cured at 98° for six hours, the value dropped to 172. Parboiled rice prepared from the paddy, by the indigenous method, had a swelling number of 248, while the paddy on curing

by long storage at 25° yielded rice with S.N. 311. Important conclusions arrived at were: (*a*) Rice from freshly harvested paddy (which is notorious for its poor cooking quality) gives a very low swelling number, (*b*) storage, or proper heat treatment improves the cooking quality of freshly harvested paddy, (*c*) overcuring adversely affects the quality, and (*d*) parboiled rice swells less than raw rice, when cooked under the same conditions.

Rice obtained from fresh paddy is well known to be unsuitable as food since it gives rise to severe digestive disturbances. In India, the paddy is generally stored for 3 to 6 months before it is hulled. In pre-war years, the market value of paddy, even after three months' storage, used to be about 20% less than that of paddy that had been stored for a year. It is obvious that any process that cuts short the curing process will be of economic importance. In South India, in times of scarcity of rice, it is not unusual to hasten the curing by keeping the paddy along with the straw, in heaps, for some days. Marked improvement in quality is obtained by such storage, under conditions which lead to conservation of heat and moisture. This form of curing however, is obviously crude and does not give an uniformly cured product.

The unsuitability as food, of rice from fresh paddy seems to be due, to at least two causes. One is its poor swelling when cooked. Cooked rice that has swollen presents a large internal surface at which the enzymes which effect the digestion of starch, can be adsorbed and can act efficiently. When swelling is poor, enzymic digestion of starch in the alimentary canal is unsatisfactory and the improperly digested starch is attacked by bacteria and causes undesirable effects.

Another reason for the poor quality of rice from fresh paddy seems to be the poor permeability of the envelope surrounding the starch granules. Reichert states, with reference to starches in general, that " If the coating of the starch granule is perfect, there is no enzyme action *in vitro*, even in twelve months at optimal temperature" (" The Differentiation and Specificity of Starches," p. 177; *cf. Jansch*, *Arch. Verdauungs-Krankh*, 1937, **61**, 278, cited from *Chem. Abstracts*, 1938, **32**, 1301).

The swelling of starches has received considerable attention in recent years (Alsberg, *Plant Physiology*, 1938, **13**, 295; Mullen and Pascu, *Ind. Eng. Chem.* 1942, **34**, 807; Bear and Samsa, *Ibid.*, 1943, **35**, 721; Badenhuizen, *Rec. trav. botan. neerland*, 1938, **35**, 559; Harris and Jesperson, *Food Research*, 1946, **11**, 216; *J. Colloid. Sci.*, 1946, **1**, 479; *Colloid Chemistry*, by Jerome Alexander, Vol. V, p. 673). It is generally recognised that the starch granules enlarge by tangential expansion and not by development of internal, radially directed pressure. Swelling is influenced by the following factors: (1) original size of granule; (2) relative percentages of amylose and amylopectin; (3) extent of crystallisation of starch and the nature of the crystallites in the granules; and (4) whether the structure of the granule has been

previously influenced by chemical or physical treatment. Some of these factors are of particular importance with reference to processes for curing rice. Hydrogen bonding seems to play a part in the swelling of starch. Cations have been found to have a marked effect on the swelling (Repperton, *Hawaii Agr. Exptl. Sta. Bull.*. 1931, **68,** 48; Meiss, Treadway and Smith, *Ind. Eng. Chem.*, 1944, **36,** 159).

It should be noted that all these investigations on the swelling of starch have been carried out with granules that have been detached from their natural setting in the raw material. We, however, are concerned with the overall swelling of the rice grain in its cooked state, as served at the table. While wheat is converted into flour and from the flour are prepared articles of food like bread, chapathi or macaroni, the rice grain receives very little treatment, apart from polishing, before it is cooked and made ready for the table. The cooked grain is therefore merely the original rice grain that has imbibed water and has swollen. The swollen granules continue to be in the original framework of the rice grain. In fact, if in the process of swelling, the granules detach themselves from the framework, the quality of the rice is considered to be very poor indeed.

The principal material that binds the starch granules into a rigid structure seems to be the protein in rice. It is well known that proteins form complexes with carbohydrates. The latter also form complexes with fats, phosphoric acid and silicic acid and it is probable that the formation of such complexes also plays a part, in building up the structure of the rice grain, out of the constituent starch granules. Sjostrom (*Ind. Eng. Chem.*, 1936, **28,** 63) pictures the granules in the rice grain as enclosed in honeycomb-like structures of gluten and states that in the aggregates, the granules are held together by the gluten particles. The cementing material in rice is strong and necessitates the use of drastic reagents in breaking down the structure of the grain in the production of rice starch (*Industrial Chemistry* by Rogers, 1942, **2,** 1404). The term " Cohesive Colloids " has been applied by Jerome Alexander to binding materials like gluten which produce coherent structures (J. Alexander, *J. Soc. Chem. Ind.*, 1936, **65,** 206; *Colloid Chemistry*, Vol. V, **10,** 1944). 1% Protein seems to be the binding material in the production of a coherent structure from small glycogen units (Lazarow, *Science*, 1942, **95,** 49). The role of calcium humate in binding soils into the crumb structure is well known It has been stated by Zweifach (*Cold Spring Harbor Symposium*, 1940, **8,** 216) that a calcium protein compound binds together the cells in the capillary wall.

The framework of the rice grain is under certain circumstances rather a delicate structure. For instance, if rice is exposed to the sun, or subjected to vacuum, or to dry heat, the grain is badly affected as noticed on cooking it. In processes for the curing of rice, the delicate nature of the framework has to be constantly borne in mind.

AMYLOSE AND AMYLOPECTIN IN RICE

It has already been pointed out that one of the factors affecting the swelling of starch granules is the relative proportion in them, of amylose and amylopectin, which constitute two distinct fractions of starch. Both the fractions consist of chains of glucose residues linked by alpha 1 : 4 glucosidic bonds. Particles of amylose are long and threadlike, while those of amylopectin are much more nearly spherical. Amylose largely consists of unbranched chains of 100 or more glucose members while amylopectin has branched structure composed of unit chains of about 20 glucose residues. The molecular weight of amylose is between 10,000 and 100,000 while that of amylopectin exceeds 300,000 (Haworth, *J. Chem. Soc.*, 1946, 543; Meyer, K. H., *Advances in Colloid Science,* **1**, 143). Investigations were carried out at Central College to find out how far varietal differences in amylose-amylopectin ratios would affect the swelling numbers of the different varieties of rice. The amylose and amylopectin contents of different varieties of rice were determined by potentiometric titrations carried out by the method described by Bates, French and Rundle (*J. Am. Chem. Soc.*, 1943, **65**, 142) as modified by Wilson, Schoch and Hudson (*Ibid.*, 1943, **65**, 1380). It was found that there was a close correlation between the amylose content of a rice and its swelling number (Vasudevamurthy, A. R., Subramanya, R. S., and Sanjiva Rao, B., unpublished work). Varieties of good cooking quality were found to have amylose content varying from 12 to 17%. Such varieties have high swelling numbers (270 to 305). A few varieties were noticed to have no amylose at all, the swelling number in such cases was as low as 200. The question arises if the amylose-amylopectin ratio of a rice can be altered by appropriate treatment and the cooking quality of the rice thus improved. It was found however that heat treatment of paddy by methods like parboiling did not affect the amylose-amylopectin ratio. Haworth (*loc. cit.*) has suggested a scheme for the synthesis and breakdown of amylopectin and amylose by the P. and Q. enzymes of potato. P. enzyme under appropriate conditions acts on amylopectin to yield amylose. Much more knowledge of the action of the enzyme however, will have to be obtained before we can hope to alter the quality of a rice by enzymatic action.

In starch there is a strong tendency for the formation of "Interlocked macromolecules". The formation of cross-linkages in the macromolecules, reduces swelling capacity. We may look upon rice as a colloidal system which has limited swelling capacity owing to the presence of cross-linkages. It has been suggested by Staudinger (*Trans. Far. Soc.*, 1936, **32**, 323) that such systems have long threadlike molecules linked by bridges to three-dimensional molecules. The links cause a complete change in the physical properties, especially solubility. The longer the threads and the smaller the number of links, the higher

is the swelling capacity. By controlling the cross-linkages therefore, we can modify the swelling properties (Rideal. *Trans. Far. Soc.*, 1936. **32**, 323).

Rice in fresh paddy is in a large measure in the hydrogel condition, and as the rice ages, there is elimination of water, due to syneresis. As syneresis proceeds, cross-linkages are formed and there is greater rigidity in structure, until ultimately, on adequate storage, we are able to husk the rice without undue damage. In fact, there is a very close analogy between the aging process in rice and the formation of the xerogel of silica (called "silica gel"), from the hydrogel of silicic acid. To obtain a xerogel of silica having a large internal surface ((provided by capillaries), it is usual to subject the hydrogel to what has been appropriately called "Wet-heat Treatment" (Holmes, *Ind. Eng. Chem.*, 1925, **17**, 280; 1926, **18**, 386). The treatment consists in keeping the hydrogel as hot as practicable, while preventing loss of moisture. It may be noted that in the rice grain also, there are capillary spaces as in silica gel. These capillaries have been studied at Central College. Employing a special technique, which he later used to estimate the capillary spaces in silica gel, M. R. A. Rao actually measured the volume of air entrapped in rice capillaries. (M. R. A. Rao, *J. Ind. Chem. Soc.*, 1935, **12**, 336). The sorption of water vapour by rice grain was carefully studied by K. Subba Rao (*Curr. Sci.*, 1939, **8**, 256) with particular reference to hysteresis in sorption, which he has explained on the basis of the existence of cavities with narrow necks. His work showed that some of the cavities in rice were of molecular dimensions. The hysteresis loops in rice disappeared on successive sorption and desorption of water vapour, but not of carbon tetrachloride vapour by the rice. It may be mentioned that the hysteresis loops in silica gel persist even after a large number of cycles of sorption and desorption. The difference is of significance. While the capillary walls of silica gel are rigid, those of rice, which is a swelling gel, are elastic. In fact, when rice grains undergo a series of sorptions and desorptions, there is a considerable gain in the elasticity of the walls, leading to the final disappearance of the hysteresis loop.

Parboiled Rice

The fact that rigidity in structure, in the rice grain, can be attained by the application of wet heat and the consequent development of cross-linkages, is of great practical importance and is the basis of several methods of curing rice. One of the oldest of such methods, is the parboiling, of paddy. This method of curing rice has been followed in India for a very long time. Originally, the aim of parboiling was to render the husking of rice easy. Parboiling however, accomplishes much more than that. The out-turn of parboiled rice is usually 6 to 10% more than that of ordinary milled rice (*Report of the Rice Study Group of FAO*,

1947, p. 14). Parboiling leads to a conservation of the water-soluble vitamins of the B group—thiamin, niacin and riboflavin in particular, and also of protein and mineral matter, of nutritional importance (Aykroyd, *J. of Hygiene*, 1932, **32**, 184; Subramanyan, Sreenivasan and Das Gupta, *Indian J. Agri. Sci.*, 1938, **8**, 459; Sreenivasan, *Indian Med. J.*, 1938, **32**, 1). When rice has been properly parboiled, the keeping quality of the rice also improves, partly because the vitamins in the cured rice are not readily available to the weevils. Another important advantage of parboiling is that when parboiled rice is washed, prior to its cooking (and rice invariably is washed before it is cooked), the loss of thiamin is about 8% only, while raw milled rice loses 60% of its thiamin, on washing (Swaminathan, *Indian J. Med. Research*, 1942, **30**, 409). Striking difference in loss of vitamin on washing has also been noticed by Kik, between parboiled rice and raw milled rice (*The Nutritional Improvement of White Rice*, by Kik and Williams, 1945, p. 19).

In parboiling, the paddy is first soaked in water for a period varying from 24 to 72 hours. During this process, the water-soluble vitamins and other nutrients present in the bran layers, move into the endosperm. The rice imbibes water and becomes a hydrogel. The paddy is then boiled in water or heated by steam. This constitutes the "Wet-heat treatment" which develops cross-linkages in the grain. As a result of the partial gelatinisation of the starch, the vitamins are firmly fixed in the endosperm and are far less readily washed out. A good account of the different methods employed in parboiling has been given by Ramiah (*Rice in Madras*, 1937, p. 90). The process has scarcely been standardised. In the FAO report on the "Rice Economy of Asia" it is rightly observed "The traditional rule-of-thumb parboiling process needs to be rationalized by careful investigation of each stage of the process, with a view to modification and improvement." The need for reform in parboiling has also been emphasised by the Rice Study Group of the FAO in its report (1947): "The process of parboiling has not been standardised. Rule-of-thumb methods are being used. With a view to securing increased weight, millers often do not dry parboiled rice to the required extent. Such rice does not keep well and develops an unpleasant flavour. Parboiled rice is thus of varying quality and there is a strong consumer prejudice against it in certain Asiatic countries. It is considered important that the parboiling process should be standardised to eliminate malpractices. There is need for developing equipment and facilities suitable for small-scale parboiling operations".

The chief defects of improperly parboiled rice seem to be: (1) objectionable odour, (2) uninviting taste, and (3) toughness of the cooked grain. The first two undesirable features can be eliminated to a large extent, by reducing the period of soaking of paddy and by employing hot water for soaking. This aspect of the problem has been investigated at Central College,

and we recommend that soaking be carried out for a period of two to three hours at a temperature of 70° C. M. C. Kik has carried out extensive tests on parboiling (*Rice Journal*, July 1946). His results also show that it is advantageous to have a comparatively short soaking period in water in the neighbourhood of 70° (*cf.* Charlton, *Bulletin* 46, *Agri. Res. Inst.*, Pusa, 1923).

When cold water is used for soaking paddy, and the duration of soaking is 24 to 72 hours, a great deal of fermentation takes place, particularly if the paddy has not been thoroughly cleaned to remove objectionable impurities like cowdung. Fermentation can no doubt be minimised if the soak water is frequently changed, but the need for frequent replacement of the soak water does not seem to have been realised by millers.

Objectionable odours are likely to develop in parboiled rice during the sun-drying of the cured paddy, unless proper care is taken to see that the drying yards are maintained in a sanitary condition. Sun-drying of parboiled paddy is beset with so many difficulties, that a very necessary reform is the introduction of mechanical dryers. There is a great need in rice technology for a dryer that can economically handle the drying of parboiled paddy in quantities of the order of two tons.

Another essential improvement is the frequent determination of moisture in paddy that is being dried. In American factories, where paddy is cured by certain improved methods of parboiling, moisture determinations are carried out every 15 or 30 minutes on cured paddy that is being dried. In India the miller relies on his "Experience" and this frequently leads to poor quality of the parboiled rice. It should be noted that the extent of moisture in rice profoundly affects its storage. The Rice Study Group, in its report (p. 14) points out "It is essential that rice intended for storage have a low moisture content. This should not exceed 10 to 12 per cent. in India".

A defect of parboiled rice which has been partly responsible for its rather limited popularity, is that parboiled rice when cooked yields a tougher product than that given by raw polished rice. "Tenderness testers" are now being used in food technology in America, to express quantitatively the tenderness of foods. Attempts at Central College to design a suitable instrument for use with cooked rice have not been successful but we find that the swelling number can be used as a rough index of the tenderness of the cooked rice. Parboiled rices have been found to have swelling numbers ranging from 240 to 250, while raw polished rices of good cooking quality have swelling numbers ranging from 300 to 320. Parboiled rice therefore appears to be an overcured product. By reducing the duration and the temperature of gelatinization of starch, it is practicable to obtain a parboiled rice having a higher swelling number, but the grain will be less hard and there will be a greater loss in milling, due to breakage. We have therefore to fix an optimum for the swelling number, taking into account the preference of certain consumers

for softness in cooked rice, as also the gain in head rice that is secured by greater gelatinization of the starch.

Rice Conversion and Malek Process

In recent years, several attempts have been made to modernize the parboiling process, and rice is now cured in America on the large scale by two patented processes—"Rice Conversion Process" (*Food Industries*, 763, 1947) and "Malek Process" (*Ibid.*, 1192, 1947). It has to be noted that these processes are fundamentally akin to the parboiling process, that has been in use in India for ages. M. C. Kik and R. R. Williams in their report on "The Nutritional Improvement of White Rice" (1945), p. 62, state "We are unable to point out clear-cut and obvious evidence of fundamental invention over some of the traditional processes in use in the Orient, nor have these questions been adjudicated by the courts so far as the present authors are aware". In the Rice Conversion Process, the soaking of paddy is facilitated by the employment of vacuum to suck out the air present in the capillaries. Hot water at about 93° C. is used for soaking, a pressure of 100 lbs. being applied to hasten the movement of water into the endosperm of rice. Steam is used for the gelatinization of the starch, which is effected in rotary driers, wherein the paddy is later dried under vacuum. In the Malek Process, the soaking is carried out at a temperature of 82° C., the gelatinization is effected in a rotating steamer, and a special type of drier—the Berico Rice Drier is used for drying the cured paddy. Both these processes give a high yield of head rice. The processes however, can be successfully used only on the large scale and it is doubtful if they can be accepted for general use in India. Vitamin conservation is quite satisfactory, that in the rice conversion process being appreciably higher (p. 63 *et seq.* The Nutritional Improvement of White Rice). The swelling numbers of several samples of converted rice were determined at Central College and found to be even smaller than those of parboiled rices of India. Consumers' tests on converted rice were carried out in India recently, on a fairly large scale, under the auspices of the Ministry of Food. It was generally felt that converted rice, on cooking, did not yield a sufficiently soft product acceptable to consumers in India, accustomed to raw, polished rice.

Calcured Rice

In an endeavour to obtain a form of cured rice that has the appearance of raw, polished rice, as also its cooking quality, while having at the same time, all the desirable features of parboiled rice a modified process of curing rice has been developed at Central College (B. Sanjiva Rao, R. S. Subramanya and K. Srinivasan, 1946). In this process, the paddy is soaked in a dilute solution (0·2 molar) of calcium chloride the pH of which is adjusted to 4·5. The soaking is carried out for 2 hours, the temperature of the solution being 70°C. The solution is drained

off, and the gelatinization of the starch is effected by heating the paddy with steam to a temperature of 98°C. The paddy is then dried and husked. It will be noticed that in the calcuring process. the duration of soaking is kept low so that discoloration of the rice by the xanthophyllic colouring matter from the husk is reduced to a minimum. By adjusting the pH of the solution to 4·5 the dispersion of the colouring matter is reduced. The very feeble acidity of the solution also helps to minimise the thermal destruction of thiamin. In this process, the gelatinization of starch is carried out to a very moderate extent as compared with other processes for the curing of rice, the necessary rigidity in structure of the grain being secured by the employment of calcium ion to modify the colloidal properties of starch and of the protein, which as already stated, is the cohesive colloid that holds together the rice granules. Instances of superior cohesive action possessed by calcium proteinates have been given earlier. It may be mentioned that unlike alkali proteinates, the calcium complex is electrolytically dissociated to a very small extent. When rice is soaked in calcium chloride solution, there is an exchange of cations, the potassium in the rice partially goes into solution and is replaced by calcium. The colloidal properties of starch also are modified by calcium ion (*cf. Colloid Chemistry* by J. Alexander, Vol. IV, 673).

In the calcuring process, the gelatinisation of starch is so adjusted that there is no appreciable fall in the swelling number of the rice. For instance, when a variety of rice having in raw polished form, a swelling number of 320, is calcured, its swelling number drops only to a small extent, the value being 300. Calcured rice when cooked, is soft unlike other forms of cured rice. Each cooked grain however, retains its individuality. The cooked rice has no objectionable flavour. The calcium content of calcured rice is about five times that of ordinary, raw polished rice. There is thus some nutritional improvement owing to higher calcium content. It is of interest to note the growing tendency to use calcium salts in food technology. Calcium chloride is used in canning tomatoes to give them firmness. Latterly, calcium chloride has been used for rendering apples firm (*Fruit Products J.*, 1946, **25**, 200, 217, cited from *C.A.*, 1947, **41**, 4248). The importance of calcium salts in water for cooking food, has been stressed by Derstroff (*Umschau*, 1940, **44**, 696, cited from *C.A.*, 1942, **36**, 6210) who points out that calcium prevents nutrients being leached out, prevents oxidation of ascorbic acid, and the "decomposition" of proteins, and preserves the flavour and appearance of vegetables and fruits. The use of calcium salts in water, used for cooking vegetables, has recently been advocated as a measure for enriching the calcium content of vegetables (*C.A.*, 1946, **40**, 7439).

The thiamin content of calcured rice is on an average 2·3 micrograms per gram of the cereal. The thiamin value can no doubt be increased by soaking for a longer period but this would

adversely affect the appearance of the calcured rice. The loss in thiamin on washing calcured rice is 4 to 5% as compared with the 8% loss sustained by parboiled rice and 60% by raw polished rice.

It was noticed that calcured rice was much less susceptible to insect attack than parboiled rice or raw rice. Comparative tests were carried out by Seshagiri Rao, D., of the Food Department, Mysore Government, employing the rice weevil, tribolium and rhizopertha, and he concluded that "Calcured rice is far less susceptible to insect attack than either ordinary raw (under-polished) or parboiled rice. Calcured rice is also an unfavourable medium for the development of weevils. Weevils show marked preference for raw and parboiled rice than for calcured rice, if samples of all the varieties are equally accessible to them". These findings are now being confirmed by more experimental work. It is not clear yet, how the calcium modifies the rice to make it less susceptible to insect attack. It may however be pointed that chalk is used to ward off insect attack on rice. deOng (*J. Econ. Entomol.*, 1935, **27**, 1131) points out that 1% chalk not only protects rice from insect atktac but also helps in the retention of flavour.

Attempts to use dielectric heating in the curing of rice have yielded interesting results (Sanjiva Rao, B., and Subramanya, R. S., unpublished work). The use of dielectric heating for drying cured paddy is not economically practicable. Dielectric heating however, has been found to be very advantageous in the gelatinisation of the starch because of the greater uniformity in heating that it readily provides and of the greater fixation of thiamin in the endosperm when dielectric heating is employed. In small scale experiments, 2·7 micrograms of thiamin per gram of rice were fixed while ordinary heat treatment under identical conditions yielded calcured rice having 2·3 micrograms of thiamin per gram. Further work is in progress.

The question may now be considered: What is the best form in which rice can be supplied to the consumer? The Rice Study Group of the FAO has recommended that "a large percentage of the rice supply should be parboiled since such rice keeps in good condition for longer periods"; and that "the consumption of parboiled rice or rice treated by similar methods and having higher nutritive value should be encouraged by governments, since such rice has distinct advantages over lightly milled or hand-pounded rice". In India nearly 60% of the rice consumed seems to be in the parboiled form, but parboiled rice is not at all popular in several Asian countries. The characteristic odour and the taste of parboiled rice are objected to. No doubt, many people accustomed to raw rice have during the present shortage of this cereal, changed over to parboiled rice. But it is debatable how far the change-over is of a lasting character. On the occasion of the award of the Perkin Medal to him, R. R. Williams recently

said "Humans will normally eat what they like and raise hell if deprived of it". To illustrate how difficult it is to change dietary habits, he drew attention to the avidity with which Englishmen nowadays, eat white bread on board ships taking them to America. Williams points out "Use of undermilled or brown rice is already a dead letter in areas where white rice is available in competition". (*Discovery*, April 1947.)

Williams advocates mixing with raw polished rice, prior to its cooking, a small quantity of specially treated rice, very rich in vitamins. Until India is in a position to manufacture the synthetic vitamins used in fortification of rice, this method of rectifying the nutritional defects of raw polished rice is scarcely to be commended. The proper solution seems to be a process which renders parboiled rice more attractive in appearance and in flavour. As pointed out by the Rice Study Group: "There is an urgent need for well-organised and international technical co-operation for securing improvement of the methods of parboiling rice..... An international body should extend research work on the methods of premilling rice treatment and should issue an authoritative report on the relative merits of various processes".

1280-47 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent.

Proceedings of the Thirty-fifth Indian Science Congress

PART III—ABSTRACTS

CONTENTS

35TH INDIAN SCIENCE CONGRESS, PATNA, 1948

SECTION OF CHEMISTRY

PRESIDENT: DR. B. SANJIVA RAO, M.A., PH.D. SC. (LOND.), F.N.I.

ABSTRACTS

Inorganic Chemistry

1. Nature of chemical bond—Part I. Ionic character and nuclear charges.

S. K. K. JATKAR *and* S. N. GOPALASWAMY (Bangalore)

In the discussion of the ionic character of the chmical bond, the dipole moments of the hydrogen halide molecules have played an important part. The dipole moments of HI, HBr and HCl have been used as the basis of several complex and empirical relationships between the electronegativity and ionic character. It has been found that the ionic character of a bond A–B is simply given by $\left(\frac{Z_A}{Z_A+Z_B}\right)$ W where Z_A is the nuclear charge of the hydrogen atom and Z_B the nuclear charge of the other atom and n has the values of 6, 5 3, 2 and 1, etc.

2. Nature of chemical bond—Part II. Bond energy and ionic character.

S. K. K. JATKAR *and* (MISS) S. B. KULKARNI (Bangalore)

Although the *partial* ionic character of a chemical has been the accepted basis of the nature of the Chemical Bond, the energy due to *extra* ionic nature, has been erroneously calculated by Pauling by postulating a resonance between covalent and ionic structure even in diatomic molecules and a set of electronegativity tables have been constructed which have recently been improved upon by Rice, Gordy and others. It has been found that if the *partial* covalent bond energy is taken into account the balance of the binding energy is equal to e^2/γ times the ionic character where e^2/γ is the Coulomb energy. The covalent bond energy can also be calculated by the equation of the type $\frac{1}{\sqrt{n(n+2)}} \times \frac{e^2}{\gamma}$ where $\sqrt{n(n+2)}$ is the spin factor of the valence electrons.

3. The dielectric constant and the dipole moment of mercurous chloride and vanadium pentoxide.

S. K. K. JATKAR *and* S. N. GOPALASWAMY (Bangalore)

The dielectric constant of mercurous chloride as determined by the temperature method is found to agree very well with that measured by the mixture method for solids. The dipole moment as calculated by the new equation is 1·56D, while mercuric chloride in dioxane solution gives moment

of 1·14. The ionic character of the bonds in these two chlorides as well as in mercuric bromide and mercuric iodide has been compared and discussed in the light of the nuclear charges of the bonded atoms. The dielectric constant of mercurous chloride shows a tendency to decrease with increasing temperature (11·65 at 30° C. and 11·40 at 70° C.). Vanadium pentoxide has a dielectric constant of about 27 at 30°.

4. The electric Curie temperature.

S. K. K. JATKAR *and* B. R. Y. IYENGAR (Bangalore)

Analogous to the introduction of a Curie temperature in paramagnetics, the ferroelectric substances like rochelle salt and titanates show a characteristic temperature θ. Thus the most general equation, derived previously connecting the dielectric constant and dipole moment now becomes $(\epsilon - n^2)\frac{M}{d} = \frac{4\pi N\mu^2}{3K(T-\theta)} \cdot \frac{(j+1)}{j}$. As in paramagnetism the characteristic temperature is attributed to a "molecular field effect". For a dipolar molecule, θ signifies the temperature above which it has sufficient energy to orientate in an electric field. The introduction of θ, successfully explains the temperature coefficients of the dielectric constants of a number of polar liquids and solids. The studies reveal that in associated compounds $\theta \approx$ M.P., and in crystaline solids $\theta =$ transition temperature. As in the magnetic case, for a polar substance dissolved in a normal or non polar liquid (*i.e.*, $\theta = 0$) θ gradually diminishes with dilution to zero.

5. Dielectric constant of titanates, rochelle salt. etc.

S. K. K. JATKAR *and* B. R. Y. IYENGAR (Bangalore)

The introduction of a characteristic temperature corresponding to the observed temperature of transition from a low, to a peak value of dielectric constant quantitatively accounts for the dielectric constant and its temperature coefficients, of ferroelectric substances like rochelle salt, barium titanate, etc. The moments (μ) calculated by the equation $(\epsilon - n^2)\frac{M}{d} = \frac{4\pi N\mu^2}{K(T-\theta)}$ are invariant with temperature and their magnitude is conclusive of the fact that the molecules in the lattice are associated with definite and characteristic dipole moments arising out of their orientation, in an electric field. For rochele salt the moment obtained by applying the equations implicitly to both the observed Curie points (− 15° and 22°) is the same (2·5D) while in TiO_2 and $BaOTiO_2$ the moments calculated for the high transition is the co-ordination number times the moment at the lower transition. The same is true of silica.

6. Reactions of Hyponitrites—Part III. Estimation of hyponitrite, nitrite and nitrate in presence of each other.

T. M. OZA *and* N. L. DIPALI (Ahmedabad and Dharwar)

The behaviour of sodium hyponitrite alone and in admixture with sodium nitrite, in the solid state and in solution, to several reagents has been investigated. It is found that (i) sodium hyponitrite behaves like sodium carbonate in titrations with standard mineral acids at and about 0° C. the two distinct stages being manifested, one with phenolphthalein and the other with methyl orange as indicator; the first stage corresponding with the hydrohyponitrite stage; (ii) carbon dioxide converts solid sodium hyponitrite, quantitatively, into sodium carbonate so that sodium nitrite in admixture with sodium hyponitrite can be estimated by the usual methods after converting the sodium hyponitrite into sodium carbonate; (iii) sodium hyponitrite in solution almost completely decomposed on boiling the solution without forming any nitrite or nitrate so that a solution containing the two salts lends itself to the usual methods of estimating its nitrite content after

boiling; (iv) silver nitrite is much more soluble than silver hyponitrite and the former can be removed from its admixture with the latter from a freshly made precipitate of the two without very seriously impairing the amount of the latter. The silver hyponitrite left may then be dissolved out in dil. HNO_3 and titrated with standard sulphocyanide using ferric alum as indicator (Oza and Walawalkar, *J. Ind. Chem. Soc., Ind. and News Edition*, 1946, **9**, 57).

Nitrate in admixture with nitrite and hyponitrite can be estimated by destroying the hyponitrite either by boiling or by treatment with sulphuric acid of appropriate strength [Oza, Dipali and Walawalkar, *J. Univ. Bom.*, 1945, **14**, (3), 27].

7. Preparation of Nitrites of alkali and alkaline earth metals.

T. M. OZA *and* N. L. DIPALI (Ahmedabad and Dharwar)

The method of preparing nitrite of a metal by double decomposition between silver nitrite and chloride of the metal has been rendered convenient by carrying out the reaction in a strongly ammoniacal solution in which silver nitrite dissolves freely. As no evaporation of a large bulk of the solution is required for recovering the nitrite from the solution, the nitrite obtained is quite pure and contains not even a trace of nitrate as impurity.

8. The thermal Decomposition of Magnesium nitrite.

T. M. OZA *and* N. L. DIPALI (Ahmedabad and Dharwar)

Pure magnesium nitrite has been prepared and its thermal decomposition studied with a view to throw light on the mechanism of the reactions occurring and compare them with those occurring in the decomposition of alkali nitrites. A quantitative study has been made of the gaseous products and the solid residue left when the reactions are carried out with (i) same mass heated for the same period of time at varying temperatures; (ii) varying masses heated for the same period of time at a constant temperature and; (iii) same mass heated at a constant temperature for varying periods of time.

Magnesium nitrite has been selected for the study to avoid, as far as possible, the complications brought about by reactions depending upon high temperature, as magnesium nitrite is known to decompose at comparatively low temperatures. It has been found that temperature is the controlling factor in deciding which of the two equations assigned by Ray and Ganguli applies. It has also been found that, in any case, the reactions proceed in stages and the equations of Ray and Ganguli are but the net result of the four simultaneously occurring reactions found by Oza (*J. Ind. Chem. Soc.*, 1945, **22**, 173) and Oza and Walawalkar (*J. Ind. Chem. Soc.*, 1945, **22**, 243) taking place in the decomposition of alkali nitrites.

9. Electro-chemical preparation of Sodium hydrosulphite.

C. C. PATEL, J. C. GHOSH *and* M. R. A. RAO (Bangalore)

Sodium bisulphite solution has been subjected to electrolytic reduction in an inert atmosphere using a mercury cathode and a platinum anode. The anolyte consists of a saturated solution of sodium bicarbonate separated from the catholyte by a porous pot diaphragm. Employing a concentrated solution of sodium bisulphite (30%) at 8° C.–10° C., a maximum concentration of 10·6% of hydrosulphite has been obtained with an average current efficiency of 70% (C.D. 2·6 amps./sq.d.m.). The concentration of the hydrosulphite cannot be increased further, due to the formation of thiosulphate. Maintenance of a low temperature (8° C. to 10° C.) and a suitable pH range of the catholyte (between 5 and 6) helps hydrosulphite production. Sodium silicate and formaldehyde retard the production of hydrosulphite, while nekal BX has no effect. A small quantity of zinc in mercury promotes the formation of hydrosulphite.

10. Estimation of Sodium hydrosulphite in presence of Sodium bisulphite.

C. C. PATEL *and* M. R. A. RAO (Bangalore)

The influence of sodium bisulphite on the estimation of sodium hydrosulphite was investigated employing the following four methods of analysis:

(i) Potassium ferricyanide method (both colorometrically and potentiometrically),
(ii) Indigo carmine method,
(iii) Ammoniacal copper sulphate method, and
(iv) Ammoniacal silver nitrate method (potentiometrically).

The increase in the analytical values of hydrosulphite when it is contaminated with sodium bisulphite, amounts to more than 50% in the first two methods while in the latter two, it amounts to about 10%, depending on the amount of the bisulphite present. However, when bisulphite is absent, the ferricyanide method is to be preferred on account of its simplicity, while the cuproammonium sulphate method can be adopted in presence of bisulphite as readings can easily be taken. In the latter case, a correction factor has to be applied, which depends on the amount of bisulphite present.

11. Preparation of Sodium hydrosulphite by the reduction of Sodium bisulphite with Sodium amalgam.

C. C. PATEL *and* M. R. A. RAO (Bangalore)

Sodium hydrosulphite has been prepared by the reduction of sodium bisulphite by sodium amalgam in an inert atmosphere. The formation of hydrosulphite is maximum when the temperature is maintained at 30° C. and the pH of the bisulphite solution is kept between 5 and 6. The percentage of hydrosulphite increases with the diminution of sodium content in the amalgam and the use of high concentrations of bisulphite (10%–20%). The maximum efficiency of reduction (on the basis of sodium in the amalgam) happens to be 66% when the reduction of a 10% solution of bisulphite having a pH of 5·3 is carried out at 30° C., employing a concentration of 0·03% sodium in the amalgam.

12. Kinetics of the gaseous reaction between hydrogen sulphide and sulphur dioxide in presence of catalysts.

B SANJIVA RAO *and* A. R. VASUDEVA MURTHY (Bangalore)

Certain sulphides, in presence of a small amount of moisture, catalyse the reaction between hydrogen suphide and sulphur dioxide (*cf.* B. S. Rao, *Curr. Sci.*, 1943, **12**, 323). The kinetics of this reaction was studied in a closed system using an all-glass circulation pump. The partial pressure of water in the reaction system was maintained constant with the aid of suitable hygrostats. The reaction was bimolecular. The higher the partial pressure of water in the reaction mixture, the greater was the velocity of reaction for a given catalyst. Of the suphides employed, cobalt thiomolybdate was found to be the best catalyst. Cobalt sulphide and molybdenum sulphide were less efficient. Next in order of efficiency was silver sulphide. The mechanism of the reaction is explained on the basis of formation of thiosulphurous acid as the primary product.

13. Catalytic Decomposition of Hydrogen Persulphide Vapour by Silver Sulphide.

A. R. VASUDEVA MURTHY *and* B. SANJIVA RAO (Bangalore)

Silver sulphide is known to catalyse the reaction between (*a*) hydrogen sulphide and sulphur dioxide and (*b*) hydrogen sulphide and sulphur monoxide

(and its dimer) (B. S. Rao, *Curr. Sci.*, 1943, **12**, 322; B. S. Rao and M. R. A. Rao, *ibid.*, 1943, **12**, 323). It has been found that silver sulphide also catalyses the decomposition of hydrogen persulphide vapour. The significance of this catalytic reaction is discussed in relation to the catalytic effect of the sulphide on the reaction between hydrogen sulphide and sulphur dioxide.

14. Reaction between Hydrogen Sulphide and Chloramine-T in Aqueous Solution.

B. SANJIVA RAO *and* A. R. VASUDEVA MURTHY (Bangalore)

When hydrogen sulphide is oxidised by chloramine-T in aqueous solution, part of the sulphide is oxidised to sulphur (Reaction A) and the rest to sulphate (Reaction B). The relative proportion of these two products of oxidation depends on the pH of the solution and the presence of certain catalysts. In highly acid solutions the hydrogen sulphide is completely oxidised to sulphate. At pH 0·65, B/A is 16·6; at pH 4·7, 8·6; at pH 7, 1·6; at pH 9·2, 0·83 ; and at pH 12, 0·02. Molybdic acid catalyses the oxidation to sulphate, while brucine, osmic acid and tungstic acid retard such oxidation. The results are explained on the basis that hydrogen sulphoxide is the primary product of oxidation of hydrogen sulphide and undergoes two simultaneous reactions:—(*a*) decomposition into water and sulphur, and (*b*) oxidation to sulphate.

15. The Influence of pH on the Oxidation of Hydrogen Sulphide by Potassium Iodate.

A. R. VASUDEVA MURTHY *and* B. SANJIVA RAO (Bangalore)

The oxidation of hydrogen sulphide by potassium iodate was studied in buffer solutions, varying in pH from 7 to 12. Part of the hydrogen sulphide is oxidised to sulphur (Reaction A) and the rest to sulphate (Reaction B). At pH 7, B/A is 2, but the addition of a little potassium iodide, lowers the value to 0·25. With an increase in pH, the production of sulphate is considerably reduced, B/A dropping to 0·33 at pH 11·7. Molybdic acid which catalysed the oxidation of hydrogen sulphide to sulphate by chloramine-T, diminished sulphate production in the case of iodate. Brucine and osmic acid had the same effect as in the case of chloramine-T—they diminished sulphate production. The mechanism of the oxidation is discussed.

16. Niobotartrates.

N. R. SRINIVASAN (Bangalore)

The complex compounds of Niobium with organic acids have been investigated. It has been found that tartaric acid dissolves freshly precipitated niobic acid resulting in the formation of a Metaniobotartaric acid (Srinivasan, *Curr. Sci.*, 1947, **16**, 60). Some alkali niobotartrates have been prepared. Sodium and potassium niobotartrates have been prepared by reacting definite alkali niobates with calculated amounts of tartaric acid and crystallising them from water or with the addition of alcohol. They are obtained as white compounds with crystalline lustre. Their aqueous solutions are hydrolysed by mineral acids with the precipitation of niobic acid, whereas alkalies and ammonia do not cause any precipitation. A suitable method of analysis has been devised to determine the stoichiometric composition of the complex compounds. The following compounds have been isolated:

$$Na_2O \cdot Nb_2O_5 \cdot (C_4H_4O_5)_2 \cdot 10\ H_2O.$$
$$Na_2O \cdot Nb_2O_5 \cdot (C_4H_4O_5)_2 \cdot 6\ H_2O.$$
$$K_2O \cdot Nb_2O_5 \cdot (C_4H_4O_5)_2 \cdot 10\ H_2O.$$
$$K_2O \cdot Nb_2O_5 \cdot (C_4H_4O_5)_2 \cdot 6\ H_2O.$$

Physico-chemical measurements have been made with a view to elucidate their structure.

17. Studies on the formation of the complex compounds of potassium chloride and mercuric chloride—Part V.

L. N. SRIVASTAVA (Lucknow)

Further evidence from the e.m.f. measurements has been adduced in support of the formation of complex compounds in a mixture of potassium chloride and mercuric chloride solutions as reported earlier (*Proc. Ind. Sci. Congress*, 1947). The breaks in the curve correspond exactly with those obtained in the graphs for other physico-chemical properties, *e.g.*, density, viscosity and conductivity, etc.

18. Two Modifications of Copper N-Diethylbiguanide.

PRIYADARANJAN RÂY *and* NRIPENDRA NATH GHOSH (Calcutta)

Two varieties of copper N-diethylbiguanide, red and blue-violet, have been prepared, besides a number of salts of the complex base, *viz.*, chloride, hydroxo-chloride, bromide, iodide, sulphate and nitrate. From a study of the properties and reactions of the two modifications of the base, they have been represented as cis-trans isomers of a planar penetration complex with dsp^2 hybrid bonds. Among the salts of the base, only the chloride has been found to give some indication of occurring in two forms, which, however, could not be isolated in the pure state.

19. The Semi-polar Single Bond—Part I.

S. S. AHMAD (Aligarh)

Existing anomalies in the electronic theory of valency are discussed. An attempt is made to explain these anomalies on the basis of the semi-polar single bond mentioned earlier by Ingold.

20. The Semi-polar Single Bond—Part II. Boron Hydrides.

S. S. AHMAD AND S. M. ALI NAQVI (Aligarh)

Various hypotheses put forward to explain the electronic structure of the boron hydrides are examined. An attempt is made to explain the structure on the basis of the concept of the semi-polar single bond. The configuration of the molecule of diborane is theoretically deduced.

Physical Chemistry

21. Formation of complex compounds between lead nitrate and alkali nitrates—Part IV.

M. R. NAYAR *and* C. S. PANDE (Lucknow)

In this paper we describe the results obtained with two systems:

(1) *Lead nitrate-sodium nitrate-water* : where there is no indication of formation of any complex compound, and

(2) *Silver nitrate-potassium nitrate-water* : in which a complex compound is definitely known to be produced.

The physico-chemical properties studied in the first system were viscosity and conductivity, and in the other system were viscosity and E.M.F. In the sodium nitrate system, when these different values are plotted against the concentration of lead nitrate, all the plots are regular, indicating that the tendency for complex formation is practically nil, while in the $AgNO_3$ system there is one break at which the molecular ratio between KNO_3 and $AgNO_3$ follows the stoichiometric relation and corresponds to the compound $KNO_3 \cdot AgNO_3$.

The differences in the results obtained with the two systems examined enable us to say definitely that the methods of procedure followed by us are such as to reveal the formation or otherwise of complex compounds in solution, and that in the case of positive results, the formula of the compound produced can be directly read from the graph.

22. Formation of complex compounds between lead nitrate and alkali nitrates—Part V. E.M.F. Measurements.

M. R. NAYAR *and* C. S. PANDE (Lucknow)

In continuation of the previous work (Nayar and Pande, *Ind. Sci. Cong. Abst.*, 1947, **19**, 4), we have now sought to obtain additional evidence for the formation of complex compounds from E.M.F. measurements. The two systems: KNO_3–$Pb(NO_3)_2$–H_2O and NH_4NO_3–$Pb(NO_3)_2$–H_2O were studied. A set of 25 solutions was prepared in which the concentration of alkali nitrate was kept constant, *viz.*, (1/3 M.), while that of lead nitrate varied systematically from 0·0 M. to 2/3 M. E.M.F. measurements were made by using the following type of cells.

	$Pb(NO_3)_2$	Satd.	Hg_2Cl_2	
Pb		KNO_3 or	in	Hg
	Alkali. NO_3	NH_4NO_3	KCl (N.)	

For purposes of comparison, the values obtained with lead nitrate alone, in the absence of alkali nitrates were also determined. When the E.M.F. values are plotted against the concentration of lead nitrate, three breaks are obtained in each of the two systems. The molecular ratios between the concentration of the constituents at these points correspond to three complexes as noticed before, *viz.*, (*a*) $4KNO_3.Pb(NO_3)_2$, (*b*) $2KNO_3.Pb(NO_3)_2$, and (*c*) $KNO_3.Pb(NO_3)_2$ in the system: KNO_3–$Pb(NO_3)_2$–H_2O, and (*a*) $4NH_4NO_3.Pb(NO_3)_2$, (*b*) $2NH_4NO_3.Pb(NO_3)_2$ and (*c*) $NH_4NO_3.Pb(NO_3)_2$ in the system: NH_4NO_3–$Pb(NO_3)_2$–H_2O.

23. Formation of complex compounds between lead nitrate and alkali nitrates—Part VI (Transport number measurements).

M. R. NAYAR *and* C. S. PANDE (Lucknow)

In the earlier parts of this series enough experimental evidence has been adduced to indicate the probable existence of three compounds in each of the two systems: KNO_3–$Pb(NO_3)_2$–H_2O and NH_4NO_3–$Pb(NO_3)_2$–H_2O. Attempts to isolate these compounds in the solid state failed, as they resulted in their decomposition into the constituent salts on crystallisation. Then the alternative was to investigate them while the substances were still in solution. The centre of interest was Pb ion, and in order to have a more quantitative idea of its behaviour the transport number of the ion was studied in lead nitrate solution under different conditions, *i.e.*, in the presence and absence of alkali nitrate. For purposes of comparison we record similar values obtained for Ag ion in the well-known system: KNO_3–$AgNO_3$–H_2O.

The results obtained with the experiments on transport number indicate:—

(1) significant variation in the values for Pb ion in presence of KNO_3 or NH_4NO_3;

(2) three different orders of magnitude in the values corresponding to the three different complexes assumed to exist in solution, while

(3) the values for Ag ion in presence of KNO_3 shows a very sharp change for a ratio of molecular concentrations 1 : 1, but no significant change for any further increase in the concn. of alkali nitrate, signifying that we are dealing with only one complex compound; and on the other hand,

(4) sodium nitrate affects the transport number of Pb ion to some extent showing a slight tendency for the formation of complexes, but no stoichiometric relations have been observed.

24. Dissolution of mercury in nitric acid—A kinetic study.

A. N. KAPPANNA *and* K. M. JOSHI (Nagpur)

The rate of dissolution of mercury in nitric acid has been studied. The rate depends upon the conditions of experiment. When the nitric acid is kept stirred and mercury added to it, it is found that there is no reaction at all for a while. This period of no-reaction (i) diminishes with increase in concentration of nitric acid and (2) increases with the rate of stirring when concentration of acid is kept constant. It has been found that the addition of nitrous acid initially to nitric acid diminishes this period of inertia, while mercurous ion exerts no influence.

25. Redox Potentials of Chloramine-T: Sulphonamide Systems.

A. R. VASUDEVA MURTHY *and* B. SANJIVA RAO (Bangalore)

The redox potentials of chloramine-T, sulphonamide systems have been measured in presence of suitable buffers. It is found that the potential diminishes as the pH rises. The fall in potential has been correlated with the increase in solubility of the sulphonamide, consequent on the rise in pH.

26. The ternary system silver oxide—Periodic acid—Water at 35° C.

P. B. GANGULY *and* P. P. GYANI (Patna)

The ternary system Ag_2O—Periodic acid—H_2O has been studied at 35° C. Two solid phases of compositions $5\,Ag_2O\cdot I_2O_7$ and $2\,Ag_2O\cdot I_2O_7\cdot H_2O$ have been shown to exist. They have also been isolated in the pure state and their composition studied. The compound $2\,Ag_2O\cdot I_2O_7\cdot H_2O$ is stable only in presence of excess of periodic acid and is decomposed by pure water with the separation of the compound $5\,Ag_2O\cdot I_2O_7$.

27. The surface properties of rubber hydrocarbon.

N. H. SIVARAMAKRISHNAN, M. R. A. RAO *and* J. C. GHOSH (Bangalore)

Rubber hydrocarbon has been purified by (1) fractional precipitation making use of solutions of crepe rubber in benzene, using alcohol as the precipitant, (2) alkali purification of ammoniated latex and (3) autoclave purification of the ammoniated latex. The purified samples of the rubber hydrocarbon were dissolved in benzene, chloroform, and carbon tetrachloride and the spreading property of the rubber hydrocarbon studied by employing the Langmuir-Adam trough technique. Stable films of rubber hydrocarbon were obtained with benzene and chloroform solutions while with carbon tetrachloride the films were not stable.

It has been found that for a given liquid, the dilution of the rubber solution increases the spreading power giving a limiting value at high dilutions. The limiting value for the thickness of the film for a given sample of rubber is also a function of the nature of the solvent employed. Chloroform solutions give rubber films which are half as thick as those from the benzene solutions (700 Å). The rubber hydrocarbon when spread over aqueous potassium permanganate, shows an increase in area with time. When a sample of chlorinated rubber is employed for spreading, it is observed that the thickness of this film is about one-tenth (70 Å) of that observed with pure rubber hydrocatbon.

28. Kinetics of hydrolysis of *d*-malo-lactonic acid.

J. C. GHOSH *and* M. S. MUTHANNA (Bangalore)

The kinetics of the hydrolysis of *d*-malolactonic acid in acid and in alkaline media and the effect of silver oxide on the hydrolysis of the lactonic acid and its rotational changes, have been studied. Dilute acid hydrolysis of the lactonic acid is comparatively slow and follows a bimolecular course leading to the formation of l-malic acid, while alkaline hydrolysis is monomolecular, the malic acid formed retaining the configuration of the lactone. Hydrolysis with silver oxide of varying concentrations gives malic acid of the same sign of rotation as the lactone, contrary to its action on l-bromo-succinic acid where different concentrations of silver oxide produce malic acid having different and even opposite sign of rotation with respect to l-bromo-succinic acid.

Kinetics of the hydrolysis of bromo-succinic acid with various bases has been studied at different hydrogen-ion concentrations. The results are as follows:

(1) At a given pH the monomolecular velocity constant ($1 \cdot 2 \times 10^{-3}$) remains constant.

(2) Monomolecular velocity constant increases linearly with an increas in pH.

(3) For pH not exceeding 9·6, the hydrolysis of bromo-succinic acid leads predominantly to the formation of malolactonic acid.

29. Influence of gases on the contact angle at mineral surfaces.

R. VENKATADAS, J. C. GHOSH *and* M. R. A. RAO (Bangalore)

It is generally believed that the nature of a gas has no effect on the contact angle at polished mineral surfaces. Investigations carried out in this laboratory show that the contact angle in some cases is a function of the gas also. Determination of the contact angle by the projection microscopic method indicated that the calcite surface gave a zero contact angle both with air and with carbon dioxide when the mineral was immersed under distilled water. When the mineral surface however, was allowed to remain in contact with a mixture of sodium oleate (0·02%) and sodium carbonate (0·01%) the contact angle with air was 0° while with carbon dioxide it was 90°. Similar experiments with Whitherite, Strontionite, Siderite and Cerussite showed a definite difference (over 40°) between the contact angles with air and with carbon dioxide when the minerals were treated with a mixture of sodium oleate and sodium carbonate. Similarly with sulphide minerals a difference in contact angle was observed between air and hydrogen sulphide in presence of a mixture of sodium ethyl xanthate and sodium hydroxide.

30. Nickel—Thoria—Kieselguhr (100 . 18 : 100) Catalyst for the Fischer-Tropsch Reaction.

J. C. GHOSH, N. G. BASAK *and* G. N. BADAMI (Bangalore)

The Nickel—Thoria—Kieselguhr (100 : 18 : 100) catalyst, developed in this laboratory, can be used industrially under certain conditions.

The catalyst is prepared by precipitation of the two carbonates (from nitrates) by ammonium carbonate in presence of carbon dioxide in excess. The catalyst on filtration is dried at 110° C. and then reduced at 500° C. in a current of pure hydrogen (electrolytic).

The catalyst thus prepared, yields at 195° C. and at atmospheric pressure 147·5 gm. of liquid and gaseous hydrocarbons (excluding methane) per cubic metre of synthesis gas ($CO : H_2$ as 1 : 2) with a space velocity of 196·6 c.c. of gas per c.c. of catalyst per hour which compares well with that used in industrial practice.

31. Symmetry values of clay salts of silicate minerals.

S. K. MUKHERJEE *and* A. GANGULI (Calcutta)

Symmetry values of a number of colloidal salts prepared from the clay fraction of montmorillonite, mica, illite, and asbestos have been determined against various electrolytes. The orders of the replacement of cations follow in general the lyotrope series with several marked discrepancies. In this respect the behaviour of K^+ ion in the mica systems is interesting. It is held fast against added Ba^{++} and Ca^{++} which are highly adsorbable, and conversely also it displaces these cations easily from their mica salts. The crystal lattice of mica in which K^+ ion fits in well as an integral constituent is probably responsible for this behaviour of K^+ ion. The few determirations of symmetry values with the colloidal salts of asbestos, which have not been hitherto studied from this point of view, show that the cation exchange is similar to that of other minerals. Occasional departures from the lyotrope series have been observed in bentonites and illites and the effect of pH is being investigated.

32. Conditions of equilibrium in cation and anion exchange resins.

S. K. MUKHERJEE *and* S. L. GUPTA (Calcutta)

Ion exchange reactions with a cation exchanger (resorcinol-formaldehyde condensation product) and an anion exchanger (*m*-phenylene diamine-formaldehyde condensation product) have been studied to determine the mechanism underlying them. The cation exchange resin showed at first a highly variable exchange capacity which was measured by leaching with N-$BaAc_2$ and N-AmAc solutions according to the methods of Parker and Schollenberger applicable to soils and clays. On prolonged treatment with salt and acid solutions the exchange capacity gradually attained a high and almost constant value It is likely that the process of condensation did not attain equilibrium under the conditions of its preparation. The anion exchange resin was prepared under more favourable conditions and it was observed that the exchange capacity of this resin determined by estimating the amount of SO_4^{--} ion adsorbed from a sulphuric acid solution was more or less constant. In both the resins, however, the attainment of equilibrium requires a long time of contact (10 to 30 days) with the leaching solutions and the exchange is stoichiometric.

33. Nature of the exchangeable Hydrogen in Clay Minerals as revealed by Moisture Data.

S. K. MUKHERJEE *and* A. GANGULI (Calcutta)

Electrochemical studies of the interaction between hydrogen clays and clay minerals and electrolytes have demonstrated the different levels of reactivity of hydrogen ions present in an exchangeable form in the double layer of the colloidal particles. From the loss of moisture on ignition from oven-dry samples of hydrogen mica, hydrogen kaolinite and hydrogen bentonite when compared with loss of moisture under similar conditions from original samples (not converted into the hydrogen systems) it appears likely that the hydrogen ion is present in its hydrated form, *i.e.*, H_3O^+ and not as H^+. Taking for example, the mica system, the hydrogen mica will lose more moisture than the original sample due to the exchangeable hydrogen, the amount of which is known from the value of the base exchange capacity. The theoretical moisture loss from hydrogen mica can be calculated and is in close agreement with the observed value, if the hydrogen ion is assumed to be present as H_3O^+; whereas, if hydrogen ion is assumed to be present as H^+, the theoretical value is much less than the observed one. Since montmorillonite has a variable structure the calculations have been made in a different way. The " molecular weight " of the mineral has been calculated from moisture data, and compared with the accepted values. The agreement

is much closer when it is assumed that the exchangeable hydrogen ion is present as H_3O+.

34. Catalytic cracking of kerosine oil.

U. SANJIV *and* S. S. GHOSH (Bangalore)

Experiments on catalytic cracking of commercial fuel-oils, such as kerosine oil, were conducted on a laboratory scale with a view to study the economic possibilities of replacing the thermal cracking plant by a suitable catalytic cracking unit for supplying laboratory gas. The common Houdry type cracking catalysts were used. Three catalysts were used: (1) Fullers earth, (2) precipitated alumina and silica, and (3) Alumina and silica precipitated on Fullers earth. At 600° C., the best yield was obtained with catalyst (3). The gas had a high percentage of unsaturated hydrocarbons. Methane and hydrogen were also present in good amounts. The nature of the reactions is discussed.

35. Production of the *Joshi-Effect* in Oxygen under Ultra-Violet.

S. R. MOHANTY (Benares)

Joshi-effect Δi has been studied in oxygen under the ultra-violet. Purified oxygen was enclosed at 250 mm. in a Siemens' tube provided with a quartz window at one end. It was excited at different V in the range 2–5 kV of 50 cycles frequency, and irradiated in the end-on position, through the quartz window, with a quartz mercury vapour lamp and a 200 volt, 200 watt incandescent (glass) bulb. The effect is greater with the mercury lamp than with the (glass) bulb. When the short waves from the mercury lamp were cut off by the addition of glass plates over the quartz, Δi was reduced to a value sensibly similar to that obtained with the (glass) bulb. Thus *e.g.*, at 2·67 kV, the relative effect % Δi was 29 with the mercury lamp, 19 when the ultra-violet was cut off as indicated above, and 17 with the (glass) bulb. Since with a strong radiation, fluctuations in light-intensity do not alter appreciably Δi, the relatively high values for % Δi with the mercury lamp is attributable to the high frequencies in the radiations.

36. Variation with Applied Potential and Gas Pressure of *Joshi-Effect* in Oxygen under Semi-ozoniser excitation.

S. R. MOHANTY (Benares)

Previous work on *Joshi-effect* in gases referred to excitation in Siemens' tubes. The effect has now been observed in oxygen excited in wire-in-cylinder type of discharge tubes or semi-ozonisers.

A semi-ozoniser with a central high tension wire of platinum was filled with oxygen in the pressure range 10–450 mm. Hg and excited at different V varied over 0·5–3·0 kV of 50 cycles frequency. The current indicator was a reflection galvanometer actuated by a vacuo-junction.

The 'threshold potential' V_m is sensibly a linear function of the gas pressure p ; this also applies to results in Siemens' tubes. No effect is observed below V_m. Above V_m, the net effect Δi increases with V to a maximum and then decreases. Thus *e.g.*, at 150 mm., Δi was 1·00 at 0·93 kV and increased to a maximum of 2·66 at 1·87 kV; further rise in V to 2·67 kV decreased Δi to 2·45. The relative effect % Δi is maximum near V_m and decreases at higher V. Thus, at the above pressure, the maximum % Δi was 50 at 0·93 kV and decreased to 15 at 2·67 kV.

At constant i_D, the effect Δi increases with p to a maximum and then decreases. Thus, for example, at $i_D = 7$, % Δi increased from 9 at 50 mm. to 25 at 200 mm., and decreased to 21 at 450 mm. The variation with p of Δi in oxygen in Siemens' tubes is similar (Mohanty and Kamath, *Phys. Sec. Abst.*, 1947, **15**).

37. Influence of the Wall-material on the Potential Reversal of the *Joshi-Effect* in the High Frequency (H.F.), Low Frequency (L.F.) and total (L.T.) conductivity in Chlorine under Silent Discharge.

B. M. SHUKLA (Benares)

In view of Joshi's ' activated layer ' postulate, the study of the remarkable sensitivity of this phenomenon to changes of surface nature, revealed a potential reversal of Δi, from negative to positive and *vice-versa* both in i_{LT} and i_{aerial}, with a vacuo-junction as the current detector. Double diode RCA, 6H6 and triode 30 were employed as detectors respectively.

Using both the above detectors, the i_{LT} showed a pronounced $-\Delta i$ as contrasted with the observation of reversal of Δi as a function of applied potential, with the vacuo-junction as the current detector. The observations in i_{aerial}, with the triode are similar to those obtained in i_{LT}; with diode an inversion from $-\Delta i$ to $+\Delta i$ at 9·2 kV, in accordance with the results obtained with the vacuo-junction as the current detector, was observed.

The above results indicate the possible role of H.F. components for the production of $+\Delta i$ also. The use of the diode as bi-phase half-wave detector suggests the simultaneous occurrence of $\pm\Delta i$, one associated with the upper and the other with the lower half of a cycle.

38. Comparative Studies of the *Joshi-Effect* in Iodine with a Diode and other A.C. Detectors.

S. N. TEWARI (Benares)

The marked dependence on the nature of the operative conditions and the current detector employed, of the magnitude of the above phenomenon Δi was emphasised by Joshi (1943, 1945 *a*). The present work reports its comparative study with a vacuo-junction, crystal detector and 83V double diode used as half wave rectifier. Siemens' ozoniser filled with iodine gas and the walls coated with iodine was excited at 50 cycles frequency in the range 500–1800 V.

The ' threshold potential ' V_m was found to be independent of the nature of the detectors used. Positive *Joshi-effect* $+\Delta i$ was invariably observed below V_m. In the inductive coupling of the detector diode the light-effect was 38% of the current in dark. Results obtained with a vacuo-junction and a crystal detector were similar but sensibly smaller in magnitude. In the resistive coupling of the diode $\%\,\Delta i$ was considerably reduced. The influence of R in suppressing $\%\,\Delta i$ was also observed with the vacuo-junction. The introduction of R in L. T. circuit of the ozoniser damps the H. F. oscillations considerably which are the chief seat of this phenomenon.

The influence of R was markedly uniform under all conditions of excitation and free from apparently anomalous results observed when this phenomenon is studied, using a triode and a pentode as detectors at large R and V.

39. Production of *Joshi-Effect* in a Siemens' Ozoniser Discharge at Large Chlorine Pressure.

P. MALLIKARJUNAPPA (Benares)

Previous work of Deo and Padmanabhulu, Deo and Urs in these laboratories, revealed that both the net effect Δi and the relative effect $\%\,\Delta i$ decrease with temperature *t*. The *effect* also increases markedly with *p*, the gas pressure (Joshi and Deo, *Nature*, 1944, **154**, 343). The temperature influence on Δi is now studied at much larger gas pressure than used previously, *viz.*, 540 mm. The exciting potential is varied from 1–4 kV of 500 cycles frequency. The 'threshold ' potential V_m decreases with *t*. At a constant V, the discharge current *i*, Δi, and $\%\,\Delta i$ increase with *t*; the increase of *i* with *t*, is marked at large V. For example, at 2 kV, i_D in dark increased from 2·6 at 20° C.

to 3·8 at 85° C. and the net effect $\triangle i$, and % $\triangle i$ were respectively 0·4 and 15 at 20° C., and 1·5 and 40 at 85° C. The above results of the author are at variance with those of Deo and co-workers. The increase of $\triangle i$ with t is ascribed to the enhanced interaction of the excited gas with the glass walls of the ozoniser. This suggestion is in accord with the observation that the effect, at a given t, is comparatively large when the gas is '*aged*' at a higher t.

The influence of light frequency was investigated on $\triangle i$, produced at potentials 1–4 kV and also in respect of its variation by ageing; that both $\triangle i$ and % $\triangle i$ are in the order: white > violet > green > red.

40. Kinetics of the Time Variation of the *Joshi-Effect* in Chlorine under Silent Discharge.

M. V. RAMANAMURTI (Benares)

The theory of the above effect $\triangle i$ (Joshi, *Phys. Sec., Abst.*, 26; *Curr. Sci.*, 1947, **16**, 19) contemplates (i) formation of a boundary layer derived in part from adsorption of ions and excited molecules under the applied fields, when intense enough to break down the gas dielectrically (at V_m); and that (ii) photo-electric emission occurs from this boundary layer, under external irradiation, leading (iii) to the effect $\triangle i$ (*loc. cit.*). Work in these laboratories has shown that (i) is fundamental not only to the production of the *Joshi-effect* $\triangle i$ but a number of other phenomena, *e.g.*, 'ageing', and the newly observed periodic effect in N_2O–H_2 interaction. Following Joshi's observation on the pronounced influence on $\triangle i$ of ageing', *i.e.*, a time variation of the discharge current i and other quantities at a constant applied potential V, kinetic studies were made for $\triangle i$ in *freshly* prepared discharge tubes. Results have been obtained for tubes of different sizes, and excited at various applied fields the gas pressure (adjusted to optimum $\triangle i$, by preliminary trials) was fixed at 200 mm. pressure. The current i was observed at regular intervals on a reflection galvanometer actuated by a diode.

The *Joshi-effect* $\triangle i$ was found to increase progressively and become stationary after about five hours, depending upon the operative conditions. The curves $\triangle i$-time show a 'first order' reaction. Since the stages (ii) and (iii) are instantaneous and fully reversible in respect of time and the exciting parameters, the above general result is ascribed to the formation of the boundary layer in (i).

41. Studies on Electrodeposition of Bronze from a Cyanide Bath.

D. SINGH *and* N. N. S. SIDDHANTA (Benares)

Electrodeposition of bronze from a bath containing the cupro-cyanide stannate, cyanide and hydroxide of sodium was studied with respect to electrolyte concentration, inter-electrode distance, duration of electrolysis, current density, temperature and addition agents. Optimum conditions for a satisfactory deposit on copper with respect to these factors are as follows:—

Elecrolyte concentration should be such that the ratio copper to tin is 1 : 3. Otherwise, the deposit does not correspond to bronze in composition.

Inter-electrode distance of 1 cm. to 2 cm. is favourable; at greater distance less tin is deposited, and the deposit is yellowish.

Optimum duration of electrolysis is 15 to 20 minutes. Shorter duration gives a reddish deposit (copper in excess), longer duration resulting in a blackish, less adherent and non-uniform deposit, due presumably to oxidation of copper.

Optimum C.D. is 0·38 amps./dm.^{2} Lower C.D. gave a reddish deposit with high Cu content. Higher C.D. gave a black burnt deposit. Cathode efficiency at opimum C.D. is 62·5%.

Deposition was tried at temperatures ranging from 20° C. to 80° C. The yellowish colour at low temperature changed to bright white at 50° C. to 60° C., but turned black on further rise of temperature.

Use of glycerol 0·5 to 2% gave a yellow deposit. 0·5 to 3% sodium chloride, 0·5 to 1% ammonium chloride, 0·5 to 3% sodium thiosulphate

improved the quality of the deposit. Use of 0·5% to 3% hydrogen peroxide gave most satisfactory results with respect to mechanical strength, uniformity of tint and polish.

42. A Study of some Physico-Chemical Factors in the Electrodeposition of Brass.

D. SINGH *and* P. C. PRADHAN (Benares)

A detailed study has been made of the optimum conditions for a smooth and adherent deposit of brass over a *base* metal, *viz.*, iron, from a bath containing copper sulphate, zinc sulphate, sodium cyanide and ammonium hydroxide. The influence on the quality of the deposit of the following factors has been studied *inter alia*: (i) bath concentration, (ii) inter-electrode distance, (iii) time, (iv) C.D., (v) temperature, and (vi) addition agents.

At a given C.D., satisfactory deposits are obtained from a solution containing 90 gms./litre of copper sulphate and zinc sulphate in the ratio of copper : zinc :: 4 : 1 within 20–60 minutes, after which the deposit is blackish and non-adherent, due presumably to copper oxidation. The pH of the solution is maintained at 10·5 ± 0·1 and the inter-electrode distance 3 cm. Optimum C.D. is 2–3 amps./sq. ft. Further rise in C.D. makes the deposit spongy and "burnt", due to rapid depletion of metallic ion round the cathode. Low C.D. gives no deposit, probably due to hydrogen discharge. The quality of the deposit improves with an increase in the temperature upto 45° C. At temperatures above 65° C., the deposit becomes black. Use of chlorides of sodium, potassium or ammonium improves the deposit. The presence of ammonium chloride in the bath prevents the precipitation of zinc hydroxide. Organic reagents like acetone, glycerol, ethyl alcohol do not improve the quality of the deposit.

43. Formation of Formaldehyde during the Interaction of Carbon Monoxide and Hydrogen under Silent Electric Discharge—Part I. Influence of gas composition and the size of the ozoniser.

R. H. SAHASRABUDHEY *and* A. KALYANASUNDARAM (Benares)

Gas mixtures with varying proportions of carbon monoxide and hydrogen ranging from 1 : 0·5 to 1 : 3 were circulated. An excess of hydrogen favours the interaction of carbon monoxide and hydrogen. The yield of formaldehyde however, does not show a linear dependence on the proportion of hydrogen in the mixture or on the total reaction as indicated by the quantity of gas used up. The best yields of formaldehyde were obtained with gas mixtures in the range 1 : 0·9–1 : 1 of carbon monoxide and hydrogen. The apparent increase in rate of reaction, when hydrogen is in excess, is undoubtedly due to secondary changes.

With an increase in the length of the ozoniser, more of the gas mixture was found to react. A corresponding increase in formaldehyde production however, was not noticed. A yield of 3·8% of formaldehyde was obtained with a 1 : 1·2 gas mixture at gas flow of 8 litres per minute.

44. Formation of Formaldehyde during the Interaction of Carbon Monoxide and Hydrogen under Silent Electric Discharge—Part II.—Influence of rate of gas circulation and exciting potential.

R. H. SAHASRABUDHEY *and* A. KALYANASUNDARAM (Benares)

The observations reported in Part I suggested that an increased rate of gas flow might result in an increased yield of formaldehyde. The rate of circulation of the gaseous mixture was therefore, varied in the range 8–24

litres per minute. Contrary to expectations, the yield of formaldehyde decreased progressively with an increased rate of gas flow. This may be due to insufficient exposure of the gases to the exciting field or (ii) the inefficient absorption of formaldehyde by the absorbers. Investigations are in progress to elucidate these points.

Influence of applied potential ($V-V_m$) has been investigated. No reaction takes place below the threshold potential, V_m. At V_m, it is very slow. The overall reaction velocity as judged from the relative quantities of the gas mixture used up in a given time, increases progressively with the applied potential, the yields of formaldehyde on the other hand diminish. Formaldehyde formed as a primary product seems to decompose subsequently.

45. An Electrochemical approach to crystal chemical studies—Part II. The ion-dipole interaction at the mica-water interface in relation to the principle of microscopic neutrality.

R. P. MITRA *and* K. S. RAJAGOPALAN (Delhi)

When a muscovite crystal is split along its potassium-bearing plane, the K^+ ions distribute themselves equally between the two parts. If attention is now directed to the cleavage surface of one of the platelets, only one half of its exposed hexagonal rings of oxygens will be found to be occupied by K^+ ions, the other half being vacant. There will be an accumulation of 0·5 unit of (excess) posiive charge in the region of an occupied ring while a vacant one will have 0·5 unit of negative charge located at its centre. The principle of microscopic neutrality will require that an occupied ring be surrounded by vacant ones and *vice versa* in a statistical sense. In other words, positive and negative charges, each 0·5 unit in strength, will be distributed on the surface with contiguous centres of charge carrying dissimilar charges. In contact with water, the muscovite crystal will seek to get rid of these local concentrations of opposite charges by interaction with the water dipoles in a manner such that the exposed potassiums are pulled out of their hexagonal cavities, or rings and made to take up positions in between contiguously situated rings. Such a redistribution of the surface potassiums following on their interaction with the water dipoles makes the surface statistically neutral on a smaller scale than in the dry crystal and lowers the potential energy of the system—as it should—in order that it may pass on to a stabler state of equilibrium. Each K^+ ion carrying one unit of positive charge in effect balances two 0·5 units of negative charges situated at the centres of adjacent hexagonal rings. Actually, the potassiums execute oscillations between these centres but taking the time average of this oscillatory motion they may be looked upon as occupying mean positions between the centres.

46. An Electrochemical Approach to Crystal Chemical Studies—Part III. The acid character of the micas.

R. P. MITRA *and* K. S. RAJAGOPALAN (Delhi)

The micas, muscovite and phlogopite, were finely ground in an agate mortar and materials having particles with equivalent spherical diameters smaller than 2·0 microns were leached with dilute HCl to obtain the corresponding hydrogen-, or, acid micas by the replacement of the exposed potassiums by hydrogen ions. Potentiometric titration curves of aqueous suspensions of these hydrogen micas with strong bases showed a weak tribasic acid character. Pauling, on the other hand, had predicted a very strong acid character for hydrogen muscovite on the basis of his electrostatic valence rules which are generally looked upon as the cardinal principles of crystal chemistry. Apparently, factors not coming within the purview of these rules are operative. The observed tribasic acid character, of the hydrogen micas indicates the presence of hydrogen ions in three different affinity levels on the

surface. The significance of these levels from the point of view of the lattice structure of the micas has been pointed out.

47. Electrodeposition of Iron.

M. A. RAHMAN *and* S. HUSAIN (Hyderabad-Deccan)

A systematic study of the electro-deposition of iron was undertaken in order to determine optimum conditions for the electro-deposition of the metal. Ferrous sulphate baths were investigated in the first instance. A platinum coil was used as an anode and an iron plate as the cathode. A canvas diaphragm was used around the anode to avoid disturbances in the solution due to evolution of oxygen at the anode. The solution was kept well stirred during the electrolysis and the temperature was maintained constant at 30°. It was observed that the cathode potential became more negative with the increase in current density and more positive with the increase in the acidity of the bath. The current efficiency increased with the rise in temperature and increase in the concentration of Fe^{++}. It was further noticed that the cathode potential became more positive as the current efficiency decreased. Adherent deposits of coherent mass were obtained on an iron base from baths containing 0·25 M. ferrous sulphate at a current density of 0·094 amp./cm.^{2} at a temperature of 60° with a current efficiency of 98%. Presence of traces of sulphuric acid was found necessary to prevent the precipitation of hydroxides and basic salts.

48. Absorption and relaxation in Gases and Vapours.

S. K. K. JATKAR *and* D. LAXMINARAYANAN (Bangalore)

The futility of studying the combustion of fuels in engines by spectroscopic methods is obvious from the fact that the band spectra reveal only the presence of cracked radicals. The phenomena preceding the ignition is unknown. The dispersion of vapours observed by authors for linear and long chain compounds at comparatively low frequencies would indicate that in high speed internal combustion engines due to disappearance of the rotational and vibrational specific heats by the super-adiabatic phenomena, the vapours reach higher temperature on account of relaxation time, and knocking or pre-ignition takes place. The data on the explosion temperatures and pressures need revision as both oxygen and carbon dioxide are well known to show dispersion and relaxation. It has been found that the dispersion frequency depends upon van der Waals' constant '*a*' and the ratio of moments of inertia of the molecule.

49. Molecular Heats of Gases and Vapours.

S. K. K. JATKAR, D. LAXMINARAYANAN *and* R. J. SUJIR (Bangalore)

The molecular heats of gases and vapours have been measured by the ultrasonic method at 23 and 50 k.c. at different temperatures in N_2, O_2, CO, CO_2, N_2O, C_2H_2, C_2H_4, CH_3CHO, $(CH_3)_2O$, $CH_3OC_2H_5$, CH_3Cl, C_2H_5Cl, CF_2Cl_2 and CH_3Br. Of these CO_2 and $CH_3OC_2H_5$ show dispersed values at room temperature.

50. Dielectric Constant of Liquids in Polar and Non-Polar Solvents.

S. K. K. JATKAR, B. R. Y. IYENGAR *and* N. S. BHATIA (Bangalore)

The dielectric constants and densities of solutions of quinoline, nitrobenzene, chloroform, bromoform, benzylchloride, chlorobenzene, aceto-

phenone, benzaldehyde, paraldehyde, acetone, ethyl ether, '*o*'-cresol, benzylamine, acetonitrile and benzonitrile have been studied in non-polar (benzene, carbon tetrachloride and dioxane) as well as polar solvents over the entire range of concentrations at various temperatures. The change in the freedom of orientation with the variation of these parameters, *viz.*, temperature, concentration and solvent, finds quantitative basis in the new relationship which has been used to calculate moments which are discussed in relation to the structure of the molecules.

51. Dielectric Constant of Associated Liquids.

S. K. K. JATKAR *and* B. R. Y. IYENGAR (Bangalore)

The characteristic temperature θ in the mono-alcohols ethyl, propyl, butyl and amyl corresponds to their melting points. For methyl alcohol, which shows molecular rotation in the solid θ corresponds to the transition temperature indicated by specific heat measurements. Water, which also shows molecular rotation in the solid state has its θ considerably below M.P. The moments calculated by the equation $(\epsilon - n^2)\frac{M}{d} = \frac{4\pi N\mu^2}{K(T-\theta)}$ correspond to those obtained in the vapour state or in dilute solutions. For hydrocyanic and hydrofluoric acids the characteristic temperatures are considerably below the melting point.

52. Dielectric Dispersion of Polar.Liquids and Solutions.

S. K. K. JATKAR *and* B. R. Y. IYENGAR (Bangalore)

The inapplicability of Debye-Clausius-Mossotti equation to polar liquids is well known. A new relationship for the anomalous dispersion in polar liquids and solids has been derived on the basis of the theories developed by the authors. Dispersion formulæ given by Cole, Fuoss and others have been critically reviewed. The data on anomalous dispersion of proteins, amino acids, water, alcohols and homologous methacrylates have been interpreted in terms of the dipole moments as involving a single relaxation time corresponding to the rotation of the huge dipole rather than two or more relaxations postulated by previous workers. The "molecular radii" derived from the observed relaxation times using the Stokes' law have been correlated with dipole moments obtained by applying a new relationship to the dielectric constant studies on solutions of various proteins and alcohols.

53. Molecular Diamagnetism and Refraction.

S. K. K. JATKAR, N. V. SATHE *and* K. P. WARKE (Bangalore)

The ratio ($\times 10^6$) of molecular diamagnetism to refraction is 4·5, for rare gases and fluorides, 3·5 for diatomic elements and most of the inorganic halides (except the bromides and iodides of Sr, Ba, Pb and Hg, for which the ratio is 3·0), 2·5 for aliphatic compounds (except halides) and 2·0 for aromatic compounds. The theoretical basis of this relationship is discussed.

54. Dipole moments of substituted Ethyl benzoates.

P. R. JOGALEKAR, N. L. PHALNIKAR *and* B. V. BHIDE (Poona)

The dipole moments of the following substituted ethyl benzoates have been determined from their dielectric constants and refractive indicies at 30° in the liquid state using Onsager's equation:—

o-methoxy (2·26), *o*-chloro (2·38), *o*-bromo (2·29), *o*-nitro (4·12); *m*-methoxy (2·03), *m*-chloro (1·95), *m*-bromo (1·98), *m*-nitro (3·82), *m*-hydroxy (2·57), *p*-hydroxy (3·11) and *p*-methoxy (2·35). The figures in brackets represent dipole moments in Debye units. The results are discussed in relation to the structure of the esters and the influence of substituents.

55. Drought resistance of plants in relation to Hysteresis in Sorption.

K. SUBBA RAO, M. BHIMASENA RAO *and* B. SANJIVA RAO
(Bangalore)

The problem of drought resistance of plants has been investigated in relation to the hysteresis effect in sorption. As typical members of the drought resisting and nondrought resisting plants, grass and balsam were chosen for the study. Sorption and desorption of water vapour at 30° C. on the dehydrated leaves of the plants were conducted by employing the quartz fibre spring technique. Hysteresis effect was exhibited in both cases. The hysteresis effect is due to cavities which entrap water during desorption. Over the entire range of relative humidities, grass takes more water than balsam. The relative positions of the loops of the plants indicate that the cavities and their necks in the balsam leaf are much wider than those in the grass blade. This difference in the capillary structure of grass and balsam is probably one of the causes responsible for the difference in their drought resisting properties. The hysteresis effect exhibited by the leaves of a plant under varying conditions of drought, during the course of growth of the plant, is being investigated.

56. Kinetics of Consecutive Reactions: Hydrolysis of Nitriles.

G. G. MUJUMDAR, K. K. DOLE *and* D. D. KARVE (Poona)

In continuation of the previous work on the kinetics of consecutiv reactions, the investigation has been extended to include the study of an important case of unimolecular, two-step, and non-reversible consecutive reaction, wherein the two sub-reactions involved proceed with the same rate (*i.e.*, where k_1 is equal to k_2). Hydrolysis of propionitrile has been carried out in presence of sulphuric acid (5·38 N.), at 80° C., and the changes in concentrations of the original substance (nitrile), the intermediate product (amide) and the final product (ammonium salt) have been recorded. At this concentration of the catalysing acid, the hydrolysis of propionamide (k_2) also proceeds at the same rate as that of the nitrile (k_1). This is confirmed from an independent hydrolysis of propionamide under identical conditions. In the hydrolysis of the nitrile, the amide passes through a maximum concentration (9·15 c.c. when $a = 25$ c.c.) which is a specific one under such conditions. A mathematical treatment of the subject is possible on the basis of the present investigation.

57. Studies in Glass Systems—Magnetic Susceptibility of Gold dissolved in Borax Glass.

SUBODH KUMAR MAJUMDAR (Calcutta)

A suspension of metallic gold in borax glass was prepared by first heating auric chloride in a platinum crucible to about 210° and then heating it strongly (to about 800° C.) after mixing it with specially purified and dehydrated borax, until an apparently homogeneous melt was obtained. The melt was allowed to slowly solidify and the glass extracted. Different samples were prepared in this way, the maximum gold content being 3·12%. Gold, in a higher concentration, did not form a solid solution, but merely separated on the surface. The samples were isotropic under the Polarisation Microscope. The gold content of the samples was determined by an electrometric method used by Müller and Weisbrod (*Z. anorganische Chemie*, 1926, **17**, 156). The diamagnetic susceptibility of the samples was determined by a Torsion Balance used by Krishnan and Banerjee (*Phil. Trans.*, 1935, **A 231**, 235). The value of the diamagnetic susceptibility of the dissolved gold was calculated from the Additivity formula: $100\,\chi = p \cdot \chi_1 + (100 - p) \cdot \chi_2$, where χ is the observed mass susceptibility of the glass, p, the % of gold, χ_1 its mass susceptibility of

gold in the dissolved state and χ_2 is the susceptibility of the borax. The calculated value of χ_1 for dissolved gold shows an increase over its normal value with increased concentration in the glass, the maximum increase found being about 10%. The results are in keeping with the author's previous experiments on polar crystals dissolved in glass. As there is no borate formation with gold, the observed increase can be accounted for, by supposing that the crystal lattice itself is enlarged on account of the introduction of a dielectric medium, as suggested by the author in previous publications.

58. On the application of the Equation to some Supersaturated Solutions.

RAM GOPAL (Lucknow)

An examination of the applicability of Hamburger-Harbury equation (*Chem. Weekblad*, 1938, **35**, 886; *J. Phys. Chem.*, 1946, 50, 90) $\frac{ln\ c/co}{(M/\rho)^{2/3}} = K$, concerning the activity of 'wall-germs' in supersaturated solutions, has been made in this paper. It is found that crystallisation of highly supersaturated solutions of urea, oxalic and succinic acids may be due to 'wall-germs'. The value of $\frac{ln\ c/co}{(M/\rho)^{2/3}}$ has been found to be about 2400×10^{-5}.

The 'wall-germ' activity does not appear to have any influence on the low preheating effect on the spontaneous crystallisation of certain solutions, *e.g.*, those of KBr, KI, KNO_3 and $KClO_4$, etc. The value of $\frac{ln\ c/co}{(M/\rho)^{2/3}}$ varies from 2450×10^{-6} to 1470×10^{-5}.

59. Supersaturation Limits of Solutions—Part V.

RAM GOPAL (Lucknow)

The work on the limits of supersaturation in aqueous solution has been further extended. The results obtained confirm the previous observations that in most cases $T_s - T$ for any particular solute is almost independent of T_s. Further, $(T_s - T)\ \lambda$ has been found to be constant in a number of cases.

Considering λ, the heat of solution, as the lattice energy of the solute when it is kept in contact with the solvent water, an explanation for constancy of $(T_s - T)\ \lambda$ has been suggested.

It has been observed that preheating has a very little or negligible effect on $T_s - T$ in solutions of cinnamic, fumaric and maleic acids. It is pointed out that probably the unsaturated nature of these acids is responsible for this behaviour.

60. Supersaturation Limits of Solutions—Part VI.

RAM GOPAL (Lucknow)

Supersaturation limits of solutions of $(NH_4)_2Cr_2O_7$, NH_4ClO_4, and $Ba(ClO_4)_2$ in water have been determined. The results appear to show that both the perchlorates studied here behave like $KClO_4$ (*J. Ind. Chem. Soc.*, 1943, **20**, 185), *i.e.*, the limit of supersaturation $T_s - T$ is in general, not affected very much by the number of heatings and coolings. It remains almost a constant or varies only very slowly, unlike other salts of NH_4 and Ba such as $(NH_4)_2SO_4$, NH_4Cl, NH_4NO_3, $BaCl_2$ and $Ba(NO_3)_2$, in which $T_s - T$ goes on markedly increasing with the duration and intensity of heating. This obviously shows a characteristic feature of ClO_4 ion in the tendency of spontaneous crystallisation of these salts. The work is being extended to other perchlorates to discover the factor or factors responsible for this exceptional behaviour.

61. Study of the Compositions of Polychlorides from Solubility Data.

ARUN K. DEY (Saugor)

In a recent publication, Dey (*J. Ind. Chem. Soc.*, 1947, **24**, 207) has derived an expression for the calculation of the formulæ of polyiodides and polybromides from solubility data. In the case of polychlorides, however, chlorine does not show augmented solubility in alkali chlorides solutions but in presence of hydrogen chloride the solubility of chlorine is appreciably enhanced.

London has determined the values for the solubility of chlorine in hydrochloric acid solutions. From his data, the formulæ of the polychlorides have been calculated by the expression derived by Dey.

It is concluded that though the composition of hydrogen polychlorides depends on temperature, hydrogen trichloride seems to be the most predominant product at ordinary temperatures.

62. Studies in the formation of Complex Stannioxalates by Physico-Chemical Methods—Part I. Conductometric study of Sn $(OH)_4$ $H_2C_2O_4$ system.

ARUN K. DEY *and* A. K. BHATTACHARYA (Saugor)

In continuation of the studies in the complex formation between stannic tin and soluble organic acids and their salts (Dey and Bhattacharya, *Curr. Sci.*, 1945, **14**, 70; *Pro. Nat. Acad. Sci., India*, 1946) an attempt has been made to study the composition of the complex compounds formed between stannic hydroxide and oxalic acid. The method followed was the new electrical conductivity method adopted by the authors in their previous publications (*Curr. Sci.*, 1945, **14**, 69; *Nature*, 1946, **158**, 95). The conductometric curve gave breaks corresponding to the compositions of the compounds, $Sn(C_2O_4)_2$ and $Sn(C_2O_4)_2\ 2H_2C_2O_4$, thus confirming the existence of the aforesaid compounds.

63. Studies in the formation of Complex Stannioxalates by Physico-Chemical Methods—Part II. Conductometric study of Sn $(OH)_4$-$K_2C_2O_4$ system.

ARUN K. DEY (Saugor)

It has been observed (Dey, *Alld. Univ. Studies*, 1946, **22**, 7; Dey and Bhattacharya, *Proc. Nat. Acad. Sci., India*, 1946) that Potassium Oxalate has a stronger tendency to form complexes with stannic tin than oxalic acid. In this paper, the complex formation between stannic hydroxide and potassium oxalate has been investigated by the electrical conductivity method. From a study of the conductivity curve it has been concluded that the compounds formed are $Sn(C_2O_4)_2$ and $Sn(C_2O_4)_2$, $2\ K_2C_2O_4$.

64. Studies in the formation of Complex Stannioxalates by Physico-Chemical Methods—Part III. Spectroscopic study of $SnCl_4$-$H_2C_2O_4$ system.

ARUN K. DEY *and* A. K. BHATTACHARYA (Saugor)

The absorption spectra of mixtures of stannic chloride and oxalic acid solutions of various compositions have been studied in the ultra-violet region with the aid of Hilger's constant deviation quartz spectrograph, using copper arc as the source. Different thicknesses of solutions were used in a Baly's tube for absorption. The different thicknesses of the solutions required for having absorption up to 2618° A were noted. In a graph the required thicknesses were plotted against the compositions of the mixtures and the breaks in

the curve were assigned to be due to complex formation. It has been concluded that the compounds formed are Sn $(C_2O_4)_2$ and Sn $(C_2O_4)_2$, $2H_2C_2O_4$.

65. Studies in the formation of Complex Stannioxalates by Physico-Chemical Methods—Part IV. Spectroscopic study of $SnCl_4 \cdot K_2C_2O_4$ system.

ARUN K. DEY (Saugor)

The method employed for the investigation of the complex formation between stannic chloride and potassium oxalate was the same as in Part III oi the series. Evidence for the formation of the compounds Sn $(C_2O_4)_2$ and $Sn(C_2O_4)_2$, $2K_2C_2O_4$ was obtained.

66. An Electrochemical Approach to Crystal Chemical Studies—Part I. The 'ion-dipole' interaction at a 'crystal-polar liquid' interface and its electrochemical consequences.

R. P. MITRA (Delhi)

The chemical responses of a crystal towards a liquid phase will largely depend on its solubility. The damping effect of a limited solubility on chemical reactivity may be materially counterbalanced by an extensive mechanical comminution of the crystal which would unleash numerous building units of the latter having sufficient residual valencies to enable them to enter into an energetic interaction with the liquid phase. If the crystal is of the ionic type, or, partially so, and if the liquid is a polar one, *e.g.*, water, a large number of polar groups and or ions which have been brought to the surface as a result of the comminution will interact with the dipoles of the liquid giving, if the communition is of the right order, a stable suspension of the crystallites in the liquid. The stability of the suspension will be due to some sort of a 'surface dissociation' of the exposed polar groups and or ions as a result of their interaction with the solvent dipoles. This surface dissociation—its mechanism and that of the ion-dipole interaction have been discussed taking the mica-water interface as a model—will give to the suspension the character of a heterogeneous electrolytic system showing such familiar electrochemical features as quite definite and measurable conductivity and activity coefficients of the ions dissociated from the surface. It has been the object of the present series of papers to examine how far such features and their variations caused by the interactions of the crystallites with added electrolytes, *e.g.*, acids, bases and salts, are influenced by and, to that extent, reflect the nature of the building units of the crystal and the scheme on which they are built.

67. An Electrochemical Approach to Crystal Chemical Studies—Part IV. The acid character of hydroxyl groups in neutral layer-lattice silicates.

R. P. MITRA *and* K. S. RAJAGOPALAN (Delhi)

Many crystalline silicates have a layer-lattice structure. Some of them, *e.g.*, kaolinite and pyrophyllite, are made up of neutral layers held togethere by hydrogen bonds or weak van der Waal's forces. Hydroxyl groups present in the lattice frame-work of kaolinite and pyrophyllite are probably mainly responsible for their acid character and base combining power. Kaolinite has two types of OH groups in the lattice. In agreement with this, it shows a dibasic acid character when an aqueous suspension is titrated with a strong base. Pyrophyllite, on the other hand, has only one type of OH groups. This structural feature is in harmony with the fact that the potentiometric titration curve of pyrophyllite with a strong base resembles that of a weak monobasic acid.

68. A Note on Silverman's Equation for the Viscosity of Liquids

BALBHADRA PRASAD (Cuttack)

Silverman started with the idea that viscosity of a liquid could be represented by $\eta = Et$ where E is elasticity and t is the average life of associated complexes formed during the collision of molecules. He showed that $E = \frac{3}{\beta}$, where β is compressibility and $t = \frac{k' V}{\sqrt{T}} e^{\frac{Q'}{RT}}$. He further assumed that $\beta = ae^{CT}$ so he obtained the equation $\eta = \frac{k'' V}{\sqrt{T}} e^{\frac{Q'}{RT} - CT}$. It was shown by the author that in case of some liquids C was negative and if C was assumed to be zero the equation still holds good. It has been shown that $\beta = Ae^{-\frac{B}{T}}$ Therefore the Silverman's equation should take the form $\eta = \frac{kV}{\sqrt{T}} e^{\frac{Q}{RT}}$ which has the same form as the equation obtained by assuming that $C = 0$. Further $\frac{V}{\sqrt{T}}$ is either constant or an exponential function of temperature. Hence this equation really reduces itself to the form $\eta = Ae^{\frac{b}{T}}$.

69. Apparent molal volume of Ammonium Chloride at 35° C.

BALBHADRA PRASAD *and* PRASANNA KUMAR DAS (Cuttack)

Redlich and Rosenfeld by differentiating with respect to pressure the free energy equation of Debye and Hückel for strong electrolytes deduced an equation for the partial molal volume, $V = V_0 + a\sqrt{C}$. It was further shown that the apparent molal volume ϕ can also be represented by a similar equation $\phi = \phi_0 + K\sqrt{C}$ where the value of K is a constant. Experimental results showed that the volume of K was always of the same order.

$$K^{18}_{KCl} = 1\cdot73,\ K^{18}_{NaCl} = 1\cdot06,\ K^{25}_{KCl} = 2\cdot20,\ K^{25}_{CsNO_3} = 0\cdot26,$$
$$K^{35}_{KNO_3} = 0\cdot96,\ K^{35}_{NaNO_3} = 1\cdot20.$$

Recently Redlich and Bigeleisen have stated that if the above equation is written as $\phi = \phi_0 = K\sqrt{C} + K'C$. K is constant in case of HCl and $KClO_3$ at 25° C. Their experimental technique does not seem to be faultless.

Results obtained in this laboratory, with ammonium chloride do not support the views of Redlich and Bigeleisen. The equation however, admits another term as suggested by Redlich and Bigeleisen.

70. A new method of deriving Redox potential.

BALBHADRA PRASAD (Cuttack)

The usual method of deriving Redox potential based on the principle of maximum work given in text-books of Electro-Chemistry is so different from that used for deriving the Single Electrode potential that the similarity between Redox potential and single Electrode potential is sometimes lost sight of. A new proof of Redox potential, based on the principle of virtual work at equilibrium being equal to zero, has been given. As this principle is used in deriving single Electrode potentials also, the similarity between Single Electrode Potential and Redox Potential is clearly brought out.

71. The Variation of Absolute Viscosity with Temperature—Organic solutes in non-aqueous solvents.

A. N. BOSE *and* A. C. CHATTERJI (Lucknow)

The viscosity of a fairly large number of systems of non-electrolytes in non-aqueous solvents has been studied at various temperatures. It has been found that the simple Andrade's equation $\eta = Ae^{-\frac{Q}{RT}}$ is applicable to most of the systems investigated in this paper. The deviations can be explained by Rabinovich's solvate hypothesis and the depolymerisation concept of Applebey.

72. The Variation of Relative Viscosity with Temperature—Organic solutes in non-aqueous solvents.

A. C. CHATTERJI *and* A. N. BOSE (Lucknow)

Results of a fairly comprehensive study of the temperature dependence of relative viscosity, $\frac{\eta_s}{\eta_0}$, of concentrated and supersaturated solutions of non-electrolytes in non-aqueous solvents are discussed in this paper. The observed values of $\frac{\partial}{\partial f}\left(\frac{\eta_s}{\eta_0}\right)$ can be divided into three categories (i) having approximately zero variation; (ii) having positive value; and (iii) having negative value for the variation of relative viscosity. In the majority of cases the results can be explained by Rabinovich's solvate hypothesis and the depolymerisation hypothesis of Applebey.

73. The Variation of Absolute Viscosity with Concentration—(Organic solutes in non-aqueous solvents.)

A. C. CHATTERJI *and* A. N. BOSE (Lucknow)

The viscosity of non-electrolytes in non-aqueous solvents has been studied in this paper at different concentrations. It has been shown that Tamini's second equation, $ln\eta = \theta c + \phi$, is more applicable to these systems, than the first equation, $\eta = mc + n$. The value of θ and ϕ of the second equation, have been calculated. This equation of Tamini is equivalent to the equation of Arrhenius $\frac{\eta_s}{\eta_0} = A^c$ or $lu\frac{\eta_s}{\eta} = cln\,A$ or kc.

Taimini (*J. Phys. Chem.*, 1928, **32**, 604; 1929, **33**, 56) has shown that the second equation is not applicable to conentrated aqueous solutions. On the other hand he found that the first equation $\eta = mc + n$ is applicable to most of the supersaturated aqueous solutions investigated by him. In this laboratory it was also found that the first equation of Taimini, $\eta = mc + n$ is generally applicable to supersaturated aqueous solutions of electrolytes. Results obtained in this laboratory show that Arrhenius's equation or rather a modified form of it, as given by Tamini, is generally applicable to supersaturated non-aqueous solutions. Investigations are in progress to find out the cause of the difference between the behaviour of these two types of supersaturated solutions.

74. Dissociation Constant of Aceto-lead complex cation

SHRIPATI PANI (Cuttack)

The dissociation of the Aceto-lead complex cation has been studied by the E. M. F. method. The results obtained are discussed.

75. Magnetic study of mercuric and mercurous compounds.

MATA PRASAD, S. S. DHARMATTI *and* A. K. GHOSE (Bombay)

The magnetic susceptibilities of a large number of inorganic and organic compounds of mercuric and mercurous mercury have been determined by a modified Gouy's balance. The experimental values of the susceptibilities have been compared in different ways with the theoretical ones obtained by the methods of Slater and Angus, and it has been found that they are lower than the theoretical, especially in the case of the mercurous ion. The relationship between the molar susceptibility and the number of electrons in the compound has been studied graphically, and together with magnesium, zinc and cadmium, the sub-group characteristics have been analysed. From the graphs, values of different anions have been obtained and these have been discussed on the basis of the group characteristics. Ionic radii have been calculated for both the states from the ionic susceptibilities and have been compared with the values obtained by other methods.

Organic Chemistry

76. Bromination of some aryl esters of salicylic acid.

G. V. JADHAV *and* R. M. THAKKAR (Dharwar)

o-, *m*-, and *p*-Cresyl, *p*-nitrophenyl and β-naphthyl salicylates gave *o*-, *m*-, *p*-cresyl, *p*-nitrophenyl and β-naphthyl 5-bromo-salicylates, when brominated in acetic medium and using theoretical quantity of bromine. *m*-Nitrophenyl salicylate gave *m*-nitrophenyl 5-bromosalicylate in chloroform medium.

Nitrophenyl salicylates gave nitrophenyl 3 : 5-dibromo salicylates, when more bromine was used in acetic acid medium, whilst *o*-, *m*-, *p*-cresyl 3 : 5-dibromosalicylates were obtained from the corresponding 5-bromo-salicylates by using acetic acid solution of bromine in required proportion.

77. Bromination of some aryl esters of 5-nitro-salicylic acid.

G. V. JADHAV *and* R. M. THAKKAR (Dharwar)

Bromination of phenyl 5-nitrosalicylate gave phenyl 3-bromo-5-nitrosalicylate (A) in acetic acid medium whilst 4-bromophenyl 5-nitro-salicylate (B) was obtained with liquid bromine. Both (A) as well as (B) gave 4-bromophenyl 3-bromo-5-nitro-salicylate (C), the former by bromination with liquid bromine and the latter by bromination in acetic acid medium. (C) was obtained from phenyl 5-nitrosalicylate by the action of liquid bromine in presence of iodine catalyst.

o-Cresyl 5-nitrosalicylate also gave *o*-cresyl 3-bromo-5-nitrosalicylate (D) by bromination in acetic medium and 5 : 6 dibromo-*o*-cresyl 5-nitrosalicylate (E) by using liquid bromine. Both (D) and (E) gave 5 : 6 dibromo-*o*-cresyl 3-bromo-5-nitro-salicylate (F) by brominating (D) with liquid bromine and (E) with acetic acid solution of bromine. (F) is also obtained from *o*-cresyl 5-nitrosalicylate with liquid bromine in presence of iodine catalyst.

m-Cresyl 5-nitrosalicylate gave *m*-cresyl 3-bromo-5-nitrosalicylate and 4-bromo-*m*-cresyl-3-bromo-5-nitro-salicylate when bromination was done in acetic acid medium, depending upon the temperature of the reaction. It gave 2 : 4-dibromo-*m*-cresyl-5-nitrosalicylate with liquid bromine, which dibromo compound gave 2 : 4-dibromo-*m*-cresyl 3-bromo-5-nitro-salicylate when brominated in acetic acid medium. The last compound was also obtained from *m*-cresyl 5-nitro-salicylate by the action of liquid bromine in presence of iodine catalyst.

Similar interesting results were obtained in the case of *p*-cresyl 5-nitrosalicylate. Nitrophenyl 5-nitrosalicylates gave only nitrophenyl 3-bromo-5-nitro-salicylates by bromination in acetic acid medium.

78. Bromination of some aryl esters of 3-nitro-salicylic acid.

G. V. JADHAV *and* R. M. THAKKAR (Dharwar)

Bromination of phenyl, *o*-cresyl, *m*-cresyl 3-nitro-salicylates in acetic acid solution at higher temperatures gave phenyl, *o*-cresyl, and *m*-cresyl 3-nitro-5-bromo-salicylates. If however, the bromination of these esters is done with liquid bromine, phenyl 3-nitrosalicylate gave 2 : 4-dibromophenyl 3-nitro-salicylate; *o*-cresyl 3-nitro-salicylate gave 4-bromo-*o*-cresyl 3-nitrosalicylate; and *m*-cresyl 3-nitro-salicylate gave 4-bromo-*m*-cresyl 3-nitrosalicylate.

79. Interaction of Bromine and Thiocarbamide. Dimorphism of Formamidine Disulphide Salts.

R. H. SAHASRABUDHEY (Benares)

Bromine reacts with thiocarbamide in a dry chloroform medium forming a deep yellow-orange dibromo compound $CSN_2H_4Br_2$, which is not a simple addition product but has the constitution of a perbromide as evinced by the lability of its bromine to potassium iodide. The influence of various factors on its capacity of setting free iodine has been investigated. The dibromo-compound is extremely sensitive to moisture and in presence of the latter immediately decomposes into the hydrobromide of the well-known oxidation product of thiocarbamide, the so-called formamidine disulphide.

The nitrate and the picrate of formamidine disulphide were prepared by Werner's method, as also by using other oxidizing agents. In disagreement with the statements of the earlier workers it has been found that they melt at 82–85° or 138–140°, and 154° or 164° respectively. The manifestation of two melting points by these salts is evidently due to dimorphism.

80. Action of Sulphur monochloride on Thiocarbamide and Thiocarbanilide.

R. H. SAHASRABUDHEY (Benares)

Sulphur monochloride reacts in an inert solvent medium with thio-carbamide and thiocarbanilide forming salts of formamidine disulphide and phenylaminobenzthiazole respectively; a trisulphide or a tetrazine is not produced as postulated by Naik (*J.C.S.*, 1921, **119**, 1166). In these reactions it plays the role of an oxidizing agent.

The action of sulphur monochloride was also tried in aqueous, dil. alcoholic and aqueous acidic media on the thiocarbamides under investiga-tion but under these conditions the reagent appeared to decompose com-pletely and no oxidation product whether a disulphide, a benzthiazole, or a thiodiazole could be isolated.

81. Complex Zinc Compounds of the tris-series with ethylene diamine and propylene diamine.

KANAI LAL MANDAL (Calcutta)

Ethylene diamine dipropylene diamine zinc salts have been prepared by combining one molecule of a zinc salt with two molecules of propylene diamine and one molecule of ethylene diamine. Similarly propylene diamine diethylene diamine zinc compounds have been obtained by combining one molecule of a zinc salt with two molecules of ethylene diamine and one molecule of pro-pylene diamine. Though various reagents have been tried, it has not been possible to resolve zinc salts of the above two classes of compounds of the tris-series. By using *l*-propylene diamine obtained by the resolution of race-mic propylene diamine $NH_2\,CH_2\,CH\,NH_2\,CH_3$ lævorotatory complex zinc salts were obtained.

82. Electric Moment of Hexachloro-cyclohexanes.

S. K. K. JATKAR *and* (MISS) S. B. KULKARNI (Bangalore)

Commercial hexachloro-cyclohexane was separated into four isomers alpha, beta, gamma, delta, melting at 158° C., 309° C., 112·5° C. and 138° C., by fractional crystallisation from methyl alcohol. The dielectric properties of the four isomers were studied. The beta isomer, with 3 chlorine atoms in upper plane and the three others in lower plane, has zero moment. The gamma isomer (which is a very effective insecticide) has the highest moment (2·55D) which is independent of solvent and in agreement with the moment 2·55D of pure molten gammexane. The alpha isomer has a moment of 1·7D. Further work is in progress.

83. Dipole Moment of Aceto-acetic ester and Hydroxy benzoic Acids.

S. K. K. JATKAR *and* (MISS) S. B. KULKARNI (Bangalore)

The dipole moment of pure aceto-acetic ester is 3D between 20–130° C., in good agreement with the vapour value of 2·95 D. The moment in benzene and carbon tetrachloride varies from 2·5 to 2·7 D. with change of concentration between 5 to 39%. Dielectric properties of *o, m, p* hydroxy benzoic acids in dioxane at various concentration and temperature were studied. The moments, for ortho, meta and para hydroxy benzoic acids are 2·7, 2·2 and 2·55 D respectively.

84. Electric Moment of Some Drugs.

S. K. K. JATKAR *and* (MISS) S. B. KULKARNI (Bangalore)

Dielectric properties of sulfanilamide and its related compounds were studied in dioxane. Moment of sulfanilamide (5·4 D) is the vector sum of the moment of aniline (1·5) and benzene sulfonamide (4·1). Similarly moments of *p*-phenyl benzene sulfonamide $C_6H_5C_6H_5SO_2NH_2$ and *p*-amino-phenyl benzene sulfanilamide are 4·3 and 5·6 respectively. The values of the moment for barbitone and phenobarbotone are 1·10 and 1·15 D. Moment of *p*-ethoxy acetanilide is 5·3 in dioxane and 5·5 for pure molten liquid and is the vector sum of acetanilide 3·8 and the ethoxy group. Acetyl salicylic acid has a moment of 2·0 independent of concentration and solvent. Santonin has a high dipole moment of the order of 5·0 D. The moment for ascorbic acid is 3·2 D.

85. Dielectric Constant of Hydrogen Halides, Cyclohexanol, Camphor, Dimethyl Sulfate, &c.

S. K. K. JATKAR *and* (MISS) S. B. KULKARNI (Bangalore)

The moments of hydrogen halides cyclohexanol, hydrogen sulfide in solid and liquid state and that of camphor in solid state are calculated by the new equation $(\epsilon - n^2)\frac{M}{d} = \frac{4\pi Nh^2}{K(T-\theta)}$, where θ is the characteristic temperature corresponding to the observed temperature of transition at which the dielectric constant suddenly changes to a peak value. The observed values of θ are 98·4, 89·8, 66, 103 and 200° K. for HCl, HBr, HI and H_2S and cyclohexanol. For camphor the calculated θ is 58° K. The moments calculated correspond to those obtained in vapour or in dilute solution. The moments of dimethyl sulfate and diethyl sulfate calculated from the dielectric constant of pure liquid are 4·97 and 4·55 D. The high dielectric constant of the solids show that there is partial rotation of the molecules in the solid, the moment of which is diminished by coordination below the transition temperature.

86. Studies on the Formation of Grignard Reagent.

S. A. FASEEH *and* S. H. ZAHEER (Lucknow)

While attempting to effect a synthesis of phenanthrene and substituted phenanthrenes it was noticed (*Proc. Ind. Sci. Cong.*, 1941, p. 88) that while *o*-iododiphenyl reacted readily under the usual conditions with magnesium in ether solution giving an yield of 80% the Grignard reagent: all effort to prepare the magnesium derivative of substituted nitro or amino iododiphenyl proved unsuccessful. Slotta and Heller (*Ber*, 1930, **63**, 3044) have also noted the failure of ortho and para bromonitrobenzene to react with magnesium in presence of ether, iso-amyl ether or otherwise. This failure induced us to make an extensive search in the literature of the last forty years and the present authors found no mention of the formation of magnesium derivatives of an aromatic halide which in addition also contain a second substituent which is either a nitro or amino group, the only exception being the preparation by Baeyer of the Grignard reagent of the ortho and meta iodoanilines (*Ber*, 1905, **38**, 2759, 2767).

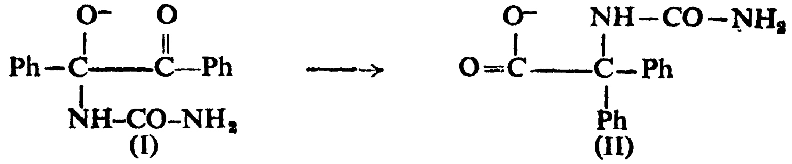
o-Chloro (and bromo) diphenyl, *o*, *m*. and *p*. chloroanilines and nitrobenzenes do not form Grignard reagent under the usual condition. By heating these compounds (in absence of air) with magnesium in sealed glass tubes the following % of the Grignard reaction has been obtained. *o*-Chloro diphenyl (32%) *o*-bromo-diphenyl (18%): ortho, meta and para chloroanilines (6%, 14% and 33% respectively). Ortho, meta and para chloronitrobenzene failed completely to produce any reaction.

87. Preparation of 5 : 5-diphenylhydantoin.

J. SIKDAR *and* T. N. GHOSH (Baranagar, Calcutta)

5 : 5-Diphenylhydantoin, (an anticonvulsant used in the treatment of epilepsy), can be prepared according to the method of Biltz (*Ber.*, 1908, **41**, 1379) which consists in treating benzil with alcoholic alkali and then heating the mixture with urea. As is well known benzil, when treated with alcoholic alkali, undergoes molecular rearrangement to benzilic acid. It was, therefore, thought that in the method of Biltz, benzil is first converted to the alkali salt of benzilic acid, which then reacts with urea to yield the alkali salt of 5 : 5-diphenylhydantoin. But, it is found that by heating, under identical conditions, the alkali salt of benzilic acid with urea in presence of alcohol, no reaction takes place.

With regard to benzilic acid rearrangement, Ingold (*Ann. Repts. Chem. Soc.*, 1928, **25**, 124; 1933, **30**, 177) has proposed the existence of an intermediate negative ion, produced by the addition of hydroxyl ion to benzil and has indicated the importance of an alkaline medium in the transformation. The above observations can be explained on the basis that urea first reacts with this intermediate negative ion and the complex (I), thus formed, next isomerises to (II), ultimately forming 5 : 5-diphenylhydantoin by cyclisation. This mechanism has been further substantiated by other experimental observations.



(I) (II)

88. Modification of Skraup's Reaction.

S. J. DAS GUPTA (Calcutta)

The Skraup's reaction for the synthesis of quinoline has been modified by various authors from time to time. In all these modifications the amino compound is mixed with the corresponding nitro compound. No modification

has yet been made in which the use of the amine is dispensed with and the nitro compound alone can be directly and safely converted to the quinoline. The author has found out a modification by which quinoline compounds can be prepared directly from the nitro compounds alone, without the slightest chance of the reaction becoming violent. A mixture of nitro compound (1 part), glycerine (3 parts) and conc. sulphuric acid (3 parts) is prepared in cold and diluted with pure formic acid (3 parts) and then refluxed under stirring at about 150° C. for several hours. The quinoline is then isolated in the usual manner.

89. Synthesis of the lactone from α-hydroxy-β-isopropyl adipic acid, the degradation product of β-phellandrene.

D. CHAKRAVARTI *and* C. N. BHAR (Calcutta)

The lactone from α-hydroxy-β-isopropyl adipic acid, the degradation product of β-phellandrene has been synthesised. Dimethyl levulinic ester has been condensed with cyanacetic ester and the condensation product reduced to ethyl α-cyano-β-isopropyl adipate, which has been hydrolysed to the tricarboxylic acid and the latter brominated and the bromo compound decomposed to α-bromo-β-isopropyl adipic acid. The above bromo compound is converted into the hydroxy acid which on distillation gives the required lactone.

90. An attempt to prepare Indigoid Dyes from acenaphthene-3-sulphonic acid.

PARESH CHANDRA DUTTA (Muzaffarpur)

Acenaphthene-3-sulphonic acid (*Ber.*, 1924, **57**, 1531) has been converted to the sulphochloride and the sulphochloride to the mercaptan by reduction. This mercaptan has next been converted to the thioglycollic acid and the thioglycollic acid to the acid chloride. But the yields of the acid and the acid chloride have been too small to make further work possible.

91. Chemical Examination of the Seeds of *Myristica attenuata.*

A. N. POTI *and* K. RAMACHANDRAN NAIR (Trivandrum)

The crushed seeds of *Myristica attenuata* on extraction with petroleum ether gave two crystalline substances, A and B and a fixed oil.

The substance A which separates from the extract at ordinary temperatures when recrystallised from alcohol gave long slender plates melting point 123° C. and showed all the characteristic colour reactions of phytosterols.

The substance B separating from the extract kept in a frigedaire gave small needles melting point 98° C. when recrystallized from petrol ether. It dissolved in sodium bicarbonate with the liberation of carbon dioxide and gave an intense violet colouration with ferric chloride showing that it might be a phenolic acid. The fixed oil obtained on evaporation of the petrol, solidified to a fat melting at 34° C.

Further work is in progress.

92. The Active Principles of the Seeds of *Swietila macrophylla.*

A. N. POTI *and* K. RAMACHANDRAN NAIR (Trivandrum)

From the seeds of *Swietila macrophylla* two non-nitrogenous crystalline substances A and B have been isolated.

The substance A ($C_{16}H_{22}O_6$) which crystallizes in rhombic plates melts at 182–183° C. and is intensely bitter to taste. It is insoluble in sodium bicarbonate but slowly goes into sodium hydroxide and is regenerated unchanged by acids. When boiled with sodium hydroxide and then acidified a distinctly

acidic white powder is precipitated. These reactions show the original substance to be a lactone. It reduces Tollens reagent indicating unsaturation at the β-position to the lactone ring.

The substance B ($C_{10}H_{26}O_5$) separates in beautiful shining prisms melting at 267° (decom.). It does not go into solution even in boiling alkali, gives a positive test with Tollens reagent and fails to give any acetyl or benzoyl derivatives. It gives a red cotouration with Hesses reagent and with Leibermann-Burchardt reagent an yellow colouration which gradually turns brown.

Further work is in progress.

93. Glyceride Constitution of the fixed oil from the seeds of *Entada scandens.*

A. N. Poti *and* K. Ramachandran Nair (Trivandrum)

After the removal of fully and disaturated glycerides by crystallization from acetone the oil was brominated in petroleum ether at 0° C. The solid and liquid bromoglycerides were further resolved into a number of fractions by different solvents. The fractions were then debrominated, saponified and acids liberated. The quantity of individual acids in each fraction was determined. From the component fatty acids in various fractions the different types of glycerides in the fractions were calculated. Assuming that the solid acids are proportionately divided in the different glycerides, the component glycerides of the oil may be given as: Disaturated olein, 12·95%; Lignocerodiolein, 2·01%; Stearodiolein, 1·17%; Palnitodiolein, 1·78%; Lignocero oleolinolein, 2·21%; Stearooleiolinolein, 1·28%; Palmitooleolinolein, 1·95%; Dioleiolinolein, 26·69%; Triolein, 48·56%; Triolein, 1·4%.

94. Glyceride Constitution of the fixed oil from the seeds of *Swietinia macrophylla.*

A. N. Poti *and* K. Ramachandran Nair (Trivandrum)

Oxidation Method—

1. The oil was oxidized by acetone permanganate and fully saturated glycerides separated.
2. From the oxidation mixture, after the removal of products easily soluble in sodium bicarbonate (like triazelain) and aliphatic acids the mixture of mono-and di-azelaoglycerides is dried and weighed and its saponification value determined.
3. The azelaic mixture was extracted with 10% sodium bicarbonate which removed only the diazelaoglycerides. It was regenerated, dried and saponification value determined.
4. From the values of (2) and (3) and knowing the amount of saturated acids present in the oil the value of mono- and di-azelaoglycerides were calculated.
5. Thus the different types of glycerides present in the oil are: (1) Fully saturated glycerides, 12·38%; (2) Disaturated mono-unsaturated glycerides, 12·69%; (3) Monosaturated diunsaturated glycerides, 46·74%; (4) Tri-unsaturated glycerides. (by diff.) 28·19%.

95. 6-Amino-α-methyl indole-2-carboxylic acid ethyl ester.

S. H. Zaheer *and* V. S. Misra (Lucknow)

The above mentioned compound, first claimed to have been prepared by Reissert and Heller (*Ber.*, 1904. 37; 4364) was prepared by us by a new method in the expectation that the compound and more particularly its methyl derivatives might have theraupetic properties. While Reissert and Heller obtained a yield of only 10%. we succeeded in obtaining a 57% yield.

The starting material was 2 ; 4 dinitrophenyl acetoacetic ester prepared by the method of Borsche (*Ber*.. 1909. **42**; 601) and not by the method of Day and Doraiswami (*J.I.C.S*.. 1933. **10**; 309–20) which proved completely unsuccessful. By adopting minor modifications of the Borsche method we succeeded in obtaining an almost theoretical yield of 2 ; 4-dinitrophenyl acetoacetic ester.

2: 4-dinitro-phenyl acetoacetic ester on reduction with iron powder and water in presence of small quantities of ferrous sulphate as catalyst gave a 57% yield of 6-amino-α-methyl-indole 2-carboxylic acid ethyl ester.

The identity of this compound was established by analysis and by the preparation of the benzoyl and 2 : 4 dinitro chlorobenzene derivatives. The compound also gives a positive carbylamine test.

On methylation, the amino compound yields a crystalline derivative (m.p., 101–102°) whose identity has however not yet been fully established.

96. Chemical Investigation of the Bitter-Principle of *Swietenia Mahogani.*

K. A. LATIFF *and* S. S. GUHA SIRCAR (Dacca)

The bitter principle from the seeds of *Swietenia Mahogany* (N. O. Meliaceæ) was found to have a tentative molecular formula of $C_{21}H_{30}O_7$. It contained no nitrogen and no aldehyde or ketone or glucosidal group, but contained possibly a tertiary alcohol, two methoxy and a lactone-group. It was unsaturated and combined with one mol. of bromine and one mol. of hydrogen.

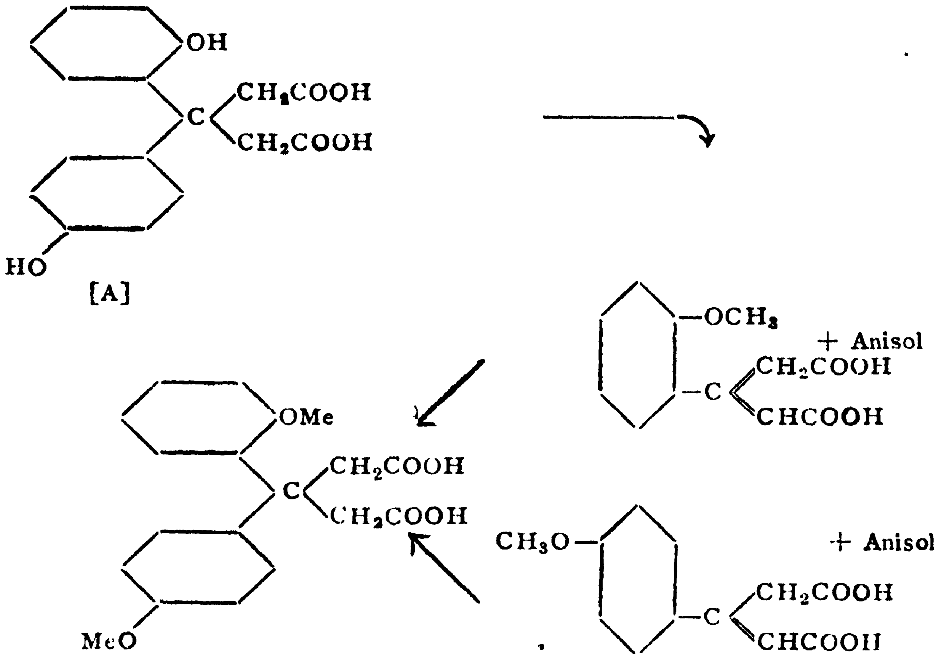
97. Constitution of the ββ-diaryl glutaric acids synthesised from phenols.

V. M. DIXIT *and* V. U. PADUKONE (Dharwar)

When phenol is condensed with acetone dicarboxylic acid in the presence of 75% sulphuric acid, the product contains a dibasic acid (m.p. 234° C. decomp.) in addition to the expected coumarin-4-acetic acid (m.p., 176° C. decomp.). Dixit and Gokhale (*J. Univ. Bom.*, 1934, **3**, 80) have suggested a constitution of ββ-di-2-hydroxyphenyl-glutaric acid for the new acid assuming that the condensation takes place in the ortho position to the -OH group in both molecules of the phenol. Gogte (*Proc. Ind. Acad. Sci.*, 1935, **2A**, 185) however assigns a constitution of ββ-di-4-hydroxyphenyl-glutaric acid for the same compound on the basis of a para condensation.

On heating with 95% sulphuric acid, the dibasic acid (m.p. 234° C.) gave a good yield of coumarin-4-acetic acid (m.p. 176° C. decomp.) as observed by Dixit and Gokhale (*loc. cit.*). The acidic filtrate from the above experiment, on bromination, gave the expected tribromophenol (m.p. 93° C.) and a dibasic acid containing bromine. This dibasic acid is considered to be a dibromo derivative of either the β-2-hydroxyphenyl glutaconic acid or the β-4-hydroxyphenyl glutaconic acid.

The original dibasic acid (m.p. 234° C. decomp.) was converted to its dimethyl derivative (m.p. 156° C.). This compound was found identical with the glutaric acid obtained by the condensation of anisol with either the β-4-methoxyphenyl glutaconic acid (m.p. 176° C. decomp.) or the β-2-methoxy-phenyl glutaconic acid (m.p. 155° C. decomp.) in the presence of 75% sulphuric acid. It appears therefore that the constitution of the original glutaric acid (m.p. 234° C. decomp.) is not symmetrical as represented before but is unsymmetrical as in (A).



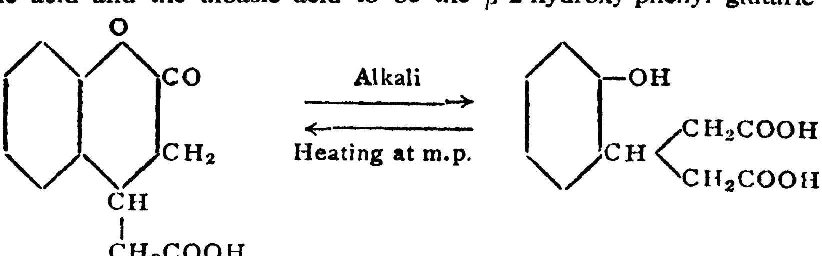
Further investigation is in progress.

98. Synthesis of Hydro-coumarins: 3 : 4-dihydro-coumarin-4-acetic acid.

V. M. DIXIT *and* V. U. PADUKONE (Dharwar)

Coumarin-4-acetic acid which was prepared by condensing phenol with acetone dicarboxylic acid in the presence of 75% sulphuric acid according to the method of Dixit and Gokhale (*J. Univ. Bom.*, 1934, **3**, 80) was reduced by sodium amalgam in alkaline solution. The product consists of (A) a monobasic acid and (B) dibasic acid.

The monobasic acid is considered to be the 3 : 4-dihydro coumarin-4-acetic acid and the dibasic acid to be the β-2-hydroxy-phenyl glutaric acid.



(A) m.p. 112° C (B) m.p. 156° C (decomp.)

(A) can be converted to (B) by hydrolysis with alkali and the reverse change is brought about by heating (B) slightly above its melting point. The identity of the glutaric acid (B) was confirmed by methylating it and identifying the methyl derivative with β-2-methoxy phenyl glutaric acid which was prepared from the known β-2-methoxy phenyl glutaconic acid (m.p. 155° C. decomp.) by reduction with sodium amalgam (Dixit, *J. Ind. Chem. Soc.*, 1931, **8**, 787). The β-2-methoxy phenyl glutaconic acid was obtained by subjecting coumarin-4-acetic acid to hydrolysis and methylation (Gogte, *Proc. Ind. Acad. Sci.*, 1934, **1**, 48).

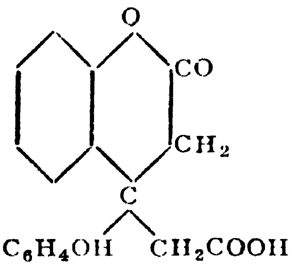
The work is being extended to coumarin-4-acetic acids prepared from other phenols, cresols and naphthols.

99. Synthesis of $\beta\beta$-diaryl glutaro-lactones.

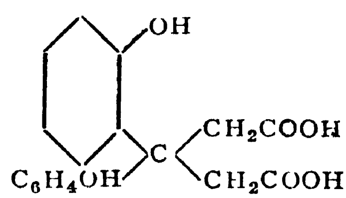
V. M. DIXIT *and* V. U. PADUKONE (Dharwar)

With the object of securing a direct synthesis of some of the $\beta\beta$-diaryl glutaro-lactones described by Dixit, Kankudti and Mulay (*J. Ind. Chem. Soc.*, 1945, **23**, 207), $\beta\beta$-di-2-hydroxy phenyl-glutaric acid (m.p. 234° C. decomp.) was prepared by the method of Dixit and Gokhale (*J. Univ. Bom.*, 1934, **3**, 80) and then heated for a few hours with phosphorus oxychloride in a dry atmosphere. Instead of the expected neutral dilactone, the product was found to be a monobasic acid (Eq. Wt. 300) which melted at a high temperature (above 260° C.) with charring. It was sparingly soluble in most of the organic solvents, but could be crystallised from a large quantity of glacial acetic acid. It gave a green colouration with ferric chloride and a sparingly soluble sodium salt. It gives the original glutaric acid (m.p. 234° C. decomp.) by hydrolysis with alkali and coumarin-4-acetic acid (m.p. 176° C. decomp.) by the action of hot conc. sulphuric acid.

The new acid is therefore considered to be a monolactonic acid of the formula (A).



(A) m.p. above 260° C.



(B) m.p. 234° C. (decomp.)

The action of phosphorus oxychloride has been extended to the other $\beta\beta$-diaryl glutaric acids and the constitution of the resulting monobasic acids is being further investigated.

100. The fixed oils from the livers of Ballistis.

K. SADASIVAN PILLAI *and* N. S. VARIER (Trivandrum)

Large shoals of Ballistis visit the Travancore Coast every year, the maximum being once in six years. Considerable quantities are caught every year. The demand for the fish being poor, its oil is extracted in quantities.

The following are its physical and chemical characteristics:—Density (at 31° C.), 0·9275; Refractive Index (at 28° C.), 1·450; Acid value, 2·436; Sap Value, 192·05; Reichert-meissel Value, 0·2574; Reichert-Polenske Value, 3·9; Iodine Value (Wij's), 149·5; Acetyl Value, 127·12; Hehner Value, 83·71; Mean Molecular weight of mixed fatty acids, 331·9; Solid Fatty Acids, 55·7%; Liquid Fatty Acids, 39·0%; Iodine Value of mixed acids, 157·2; Unsaponifiable matter, 1·175%.

Further work is in progress.

101. Chemical examination of the tubers of *Cyclea burmanni*, Part III.

P. V. NAIR *and* (MISS) P. SARADAMMA (Trivandrum)

In Part I of this series (*Abs. Proc., I.S.C.*, 1946) the authors have reported the isolation of two alkaloids (m.p. 218° and 158° C.) from the tubers of *Cyclea burmanni.* These are being provisionally named " Burmannine " and " Burmannaline ". Burmannine on oxidation with permanganate in acetone solution furnished a nitrogen-free acid (m.p. 307°–310° C.) which is under examination. The results of the action of nitric acid and of the zinc dust distillation of the alkaloid are also set forth in the paper.

102. Chemical examination of the roots of *Tiliacora racemosa*, Part II.

P. V. NAIR *and* (MISS) P. SARADAMMA (Trivandrum)

The isolation of a well-defined crystalline alkaloid (m.p. 204·5° C.) from the alcoholic extract of the roots was reported in a previous communication (*Abs. Proc., I.S.C.*, 1947). In its properties and derivatives, the alkaloid had very little in common with tiliacorin (m.p. 260° C.) which Van Itallie and Steen Hauer (*J. Soc. Chem. Ind.*, 1923, **153 A**) isolated from the bark of *Tiliacora accuminata*. The preparation of some of the derivatives of the new alkaloid and its oxidation with alkaline permanganate are described.

103. Essential Oils of Travancore—Part I. Oil from Cloves grown in S. Travancore.

K. N. GOPINATHAN NAIR, P. V. NAIR *and* N. S. VARIER (Trivandrum)

Clove cultivation was recently started at Nagercoil in S. Travancore. The present paper deals with the constants of an oil distilled from a recent crop. The moisture-free material afforded 15·5 per cent. of oil which works to roughly 9·4 per cent. on the bulk weight (including stalks) of the trade sample. The oil gave the following values:—Moisture, 8·8%; Ash Value, 6%; Density (30° C.), 1·057; Acid Value, 1·02; Sap. Value, 51·85; Phenols (Absorption with 5% KOH), 92·5%; Acetyl Value, 211·2; Ref. Index (30° C.), 1·532.

104. Molecular rearrangement of *o*-Acyloxy and *o*-Aroyloxy Acetoarones using Metallic Sodium.

SHARAD S. PANDIT *and* SURESH SETHNA (Bombay)

Orcacetophenone diacetate was heated with pulverised sodium in toluene solution. The product obtained on acidification was found to be 7-hydroxy-4-acetomethyl-5-methylcoumarin. This on deacetylation gave 7-hydroxy-4 : 5-dimethylcoumarin (Sethna and Shah, *J. Ind. Chem., Soc.*, 1940, **17**, 242). These compounds were directly compared with authentic specimens of the same prepared by Sethna and Shah.

Work on the transformation of orcacetophenone dibenzoate and the diacetates and dibenzoates of quinacetophenone and respropiophenone is in progress.

105. Chalkones from Orcacetophenone and its Monomethyl Ether.

P. B. MAHAJANI *and* SURESH SETHNA (Bombay)

Orcacetophenone has been condensed with benzaldehyde, *p*-hydroxy benzaldehyde and anisaldehyde in presence of very concentrated caustic potash solutions. The products obtained are found to be chalkone derivatives. The monomethyl ether of orcacetophenone similarly condenses with the above aldehydes to give the corresponding monomethyl ethers of the chalkones. The dihydroxy and the monomethoxy chalkones have been methylated and the dimethyl ethers have been obtained.

The work on the condensation of 2-acetyl resorcinol and its monomethyl ether with the above aldehydes is in progress.

106. Bromination of Methyl 7-Hydroxy-4-methylcoumarin-6-carboxylate and its Methyl ether.

V. J. DALVI *and* SURESH SETHNA (Bombay)

Methyl 7-hydroxy-4-methylcoumarin-6-carboxylate has been brominated with one molecule of bromine when methyl 7-hydroxy-3-bromo-4-methyl-coumarin-6-carboxylate has been obtained. This on methylation gave methyl 7-methoxy-3-bromo-4-methyl-coumarin-6-carboxylate identical with the product obtained on bromination of methyl 7-methoxy-4-methylcoumarin-6-carboxylate. The bromo compound on hydrolysis gave an acid which does not contain any bromine.

Work on the bromination of the above ester and its methyl ether with excess of bromine and the bromination of methyl 5-hydroxy-4-methylcoumarin-6-carboxylate and its methyl ether is in progress.

107. Synthesis of Thioethers.

G. V. JADHAV *and* J. R. MERCHANT (Bombay)

Thionyl chloride is condensed with *o*-hydroxy acetophenone, resacetophenone, 2-hydroxy-4-methoxy acetophenone, 2-hydroxy-4-benzoyloxy acetoephenone, 4-*o*-benzoyl resacetophenone and phloracetophenone in presencof finely divided copper, when, 3 : 3′-diacetyl-4 : 4′-dihydroxy-diphenyl thioether, 3 : 3′-diacetyl-4: 6-4′ : 6′-tetrahydroxy-diphenyl thioether, 3 : 3′-di-acetyl-4 : 4′-dihydroxy-6 : 6′-di-methoxy-diphenyl thoiether, 3 : 3′-diacetyl-4 : 4′-dihydroxy-6 : 6′-dibenzoyloxy-diphenyl thioether, 3 :3′-diacetyl- 4 :4′-dihydroxy-6 : 6′-dibenzoyloxy-diphenyl thioether and 3: 3′-diacetyl-2 : 4 : 6-2′: 4′: 6′-hexa-hydroxy-diphenyl thioether are obtained. The constitution of these thioethers has been proved by nitration when known nitro derivatives are obtained, *e.g.*, the thioether from resacetophenone gives 5-nitro-resacetophenone on nitration. The thioethers are also brominated under different conditions when bromo derivatives containing both sulphur and bromine, as well as bromo derivatives without sulphur are obtained. The action of sulphur monochloride and sulphur dichloride on the above ketones has also been studied. The work is further extended to 2-acetyl resorcinol and its derivatives.

108. Esterification of ortho and para orsellinic acids and phloroglucinol carboxylic acid.

P. R. SARAIYA *and* R. C. SHAH (Bombay)

Esterification of certain aromatic polyhydroxy acids which undergo decarboxylation readily cannot be carried out by the usual method of interaction with alcohols in the presence of sulphuric acid or hydrochloric acid. In the case of ortho and para orsellinic acids, only the methyl esters have been prepared by means of diazomethane.

However, by refluxing such acids in dry acetone with dialkylsulphate or dialkylhalide in presence of sodium or potassium bicarbonates under controlled conditions, it was possible to prepare such esters in good yield.

Thus, the methyl esters of the above acids and phloroglucinol carboxylic acid were prepared in 70–90% yield by refluxing for 8–12 hours with 1·25 moles of dimethyl sulphate and 1·5 moles of dry sodium or potassium bicarbonate. The ethyl esters of ortho and para orsellinic acids which have not been previously prepared from the acid were obtained in 70% yields by refluxing for 12 hours with 3 moles of ethyl iodide and 1·5 moles of sodium or potassium bicarbonate.

109. Addition products of anils and some metallic chlorides.

V. M. THAKOR *and* R. C. SHAH (Bombay)

Anils, from aniline, *o*-and *p*-toluidine, *o*-anisidine, etc., and β-ketonic esters, have been found to give well-defined crystalline addition products with zinc, mercuric and cadmium chlorides. Reference to literature reveals that no such addition products are known so far.

110. Condensation of butyl chloral hydrate with aromatic hydrocarbons and their halogen derivatives.

MISS L. H. DALAL *and* R. C. SHAH (Bombay)

$\alpha : \alpha : \beta$-trichloro-*n*-butaldehyde hydrate was condensed with chlorobenzene with a view to obtain a compound of possible insecticidal activity. This compound was proved to be $\alpha : \alpha$-bis-(*p*-chlorophenyl)-$\beta : \beta : \gamma$-trichloro-*n*-butane, by refluxing with alcoholic potassium hydroxide and oxidising the resulting compound to the diaryl ketone—$p : p'$-dichlorobenzophenone. Preliminary tests with this product have shown that it possesses a marked insecticidal activity.

Condensation products similar to that obtained in the condensation of $\alpha : \alpha : \beta$-trichloro-*n*-butaldehyde hydrate and chlorobenzene were obtained in the condensation of benzene, bromobenzene and naphthalene with $\alpha : \alpha : \beta$-trichloro-*n*-butaldehyde. In all these condensations two molecules of the hydrocarbon or halohydrocarbon have been found to take part.

In the condensations of anisole and phenetole with $\alpha : \alpha : \beta$-trichloro-*n*-butaldehyde, however, it has been found that only one molecule of the phenolic ethers takes part in the reaction, mono-condensation products being obtained.

111. Equilibrium in the reaction between sulphonyl chlorides and sulphuric acid.

D. V. JOSHI *and* R. C. SHAH (Bombay)

That sulphuric acid has a decomposing action on sulphonyl chlorides, was observed for the first time by Shah and Kulkarni in this laboratory (Kulkarni, *M.Sc., thesis, Bom. Univ.*, 1944). This explained why large excess of chlorosulphonic acid is required in obtaining sulphonyl chlorides in good yields.

This observation indicated the reversibility of the general reaction:

$$RSO_2Cl + H_2SO_4 \rightleftharpoons RSO_2 \cdot OH + ClSO_3H$$

In the present work the existence of equilibrium, above suggested, has been definitely experimentally established in the cases of benzene sulphonyl chloride and *p*-toluene sulphonyl chloride by studying the reactions from both the sides.

The decomposing action of 100% sulphuric acid on benzene sulphonyl chloride has also been studied at various temperatures and with different proportions and has been found to be increasing with the increase in temperature and proportion of the sulphuric acid.

112. Investigation of some methods of determining the glyceride composition of fats.

V. V. MHASKAR *and* B. V. BHIDE (Poona)

For the estimation of fully saturated glycerides in a fat, Hilditch and Lea (*J.C.S.*, 1927, 3106) developed a method which depends on the potassium permanganate oxidation of the fat in acetone solution. This method has been further extended for the estimation of fully saturated, diunsaturated and monounsaturated glycerides in a fat, by Kartha and Menon (*Proc. Ind. Acad. Sci.*, 1943, **17A**, 114.

In the present work the method has been tested by preparing synthetic fats of known glyceride composition and analysing them according to Kartha and Menon's procedure (*loc. cit.*). A mixture of tristearin, triolein, oleo-distearin and dioleostearin was prepared and analysed. The results indicate that the method is reliable within certain limitations which are discussed.

113. Studies in the chemistry of chromones—Part I. 6-hydroxy chromones.

T. R. INGLE *and* N. L. PHALNIKAR (Poona)

The preparation of 6-hydroxy substituted chromones seemed to be of interest as very few of them are known and are synthesised.

By the interaction of 2 acyl hydroquinones, ethyl formate and sodium, the following 6 hydroxy-3-alkyl (aryl) chromones have been prepared.

(1) 6-hydroxy chromone, m.p. 241 (lit. 243), acetyl derivative, m.p. 126 (lit. 126). (methyl ether, m.p. 97–98).

(2) 6-hydroxy-3-ethyl chromone, m.p. 180 (acetyl, m.p. 90: methyl ether m.p. 66).

(3) 6-hydroxy-3-benzyl chromone, m.p. 226 (acetyl, m.p. 128).

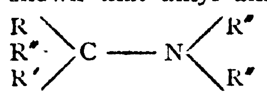
(4) 6-hydroxy-3-phenyl chromone (6 hydroxy isoflavone), m.p. 215, (acetyl, m.p. 152, methyl ether, m.p. 171).

Further work is in progress.

114. *a*-Amino (substituted) diphenyl methanes.

M. V. PATWARDHAN *and* N. L. PHALNIKAR (Poona)

Recenly it has been shown that alkyl amines of the type



(Buu Hoi, *Nature*, 1945, **156**, 392) have antitubercular properties (*cf.* Massie, Iowa State College, *J. Sci.*, 1946, **21**, 41): Borrows *et al.*, *J.C.S.*, 1947, 197).

We have prepared similar amines but with substituted phenyl groups in place of R in the above formula. A series of *a*-amino substituted diphenyl methanes (substituents, OCH_3, Cl, Br in one or both the phenyl groups) have been prepared and characterised by suitable derivatives, by the reduction of the corresponding substituted benzophenone oximes.

The antibacterial properties of these compounds are being studied.

115. Azo dyes from Sulpha drugs and naturally occurring quinone colouring matters.

N. L. PHALNIKAR (Poona)

Embellin, 2 : 5-dihydroxy-3-undecyl-*p*-benzoquinone (Nargund and Bhide, *J. Ind. Chem. Soc.*, 1930, **8**, 237; Asano and Yamaguti, *J. Pharm. Soc.* (Japan), 1940, **60**, 36) is a naturally occurring quinone. It has been coupled with diazo salts from various sulpha drugs such as. sulphanamide, sulpha-pyridine, sulphathiazole, sulphapyrimidine, etc. The resulting azo dyes are dark red coloured substances, having very high melting points.

Similar azo dyes are being prepared from other naturally occurring quinones such as lawsone, juglone, etc.

The antibacterial properties of these azo dyes are being studied.

116. Synthesis of α-Alkyl tricarbyllic acids.

N. L. PHALNIKAR (Poona)

Agaricic acid is supposed to have antitubercular properties (Roberts *Nature*, 1945, **155**, 698). Agaricic acid is cetyl citric acid, or α-cetyl-β-hydroxy tricarbyllic acid. As attempts at the synthesis of agaricic acid have so far failed, it was thought that simpler α-alkyl tricarbyllic acids might be synthesised and their antibacterial properties might be studied. Hence a series of α-alkyl tricarbyllic acids (alkyl group = propyl, *n*-butyl, isoamyl *n*-hexyl, iso-octyl, cyclohexyl, etc.) have been synthesised by the Michael reaction between dimethyl maleate and diethyl alkyl malonates. The α-alkyl tricarbyllic acids, obtained by acid hydrolysis, have been characterised by suitable derivatives.

The acids are being tested for their antibacterial properties.

117. Chemical Investigation of *Hippocratea indica* (Willd.) (N.O. Celastraceæ).

N. L. PHALNIKAR (Poona)

The investigation of this plant was undertaken at the suggestion of the Forest Utilisation Officer, Government of Bombay, Bombay.

The plant, *Hippocratea indica*, is found widely distributed in South Canara Districts of the Bombay Presidency, where it is known as 'Kangana Bally'. It is also reported that a decoction of the bark of the plant is used successfully for pneumonia. The bark and roots of the plant were, therefore, subjected to chemical analysis.

The alcohol extracts of the roots and the bark gave a substance, m.p. 187, which has been identified as dulcitol by its analysis and acetyl derivative (m.p. 169) and oxidation to mucic acid (m.p. 212–213).

A colouring matter has been also isolated and is under investigation.

118. A new glucoside from *Hydrocotyle asiatica* Linn. (N.O. Umbelliferæ).

N. L. PHALNIKAR (Poona)

Recently it has been reported that a glucoside, Asiaticoside (m.p. 232, mol. wt., 415, $[\alpha]_D = -15{\cdot}73$ in 60% ethyl alcohol from *Hydrocotyle asiatica*, N. O. Umbelliferæ (Bontemps, *Bull. Sci., Pharmacol*, 1941, **49**, 186) is an effective remedy against leprosy.

In the present work a new glucoside has been isolated from the plant collected from the neighbourhood of Poona), by extraction of the plant with alcohol. On purification, it crystallised from alcohol in cubes and had m.p. 284 with decomposition (mol. wt., 732, 742 (cryscopic, solvent alcohol) $[\alpha]_D = -32$ in absolute alcohol). From the analysis and using the above mol. wt., the molecular formula of the new glucoside comes out to be $C_{40}H_{68}O_{10}$. On hydrolysis with concentrated hydrochloric acid it gave a reducing sugar and an aglucone, giving the characteristic reactions of sterols. Further work is in progress.

Dr. Dharmendra, of the School of Tropical Medicine, Calcutta, reports that this glucoside has no action on M. Tuberculosis even in a concentration of 20 mgms. per 100 c.c.

119. A new synthesis of Cadalene.

SUKH DEV *and* P. C. GUHA (Bangalore)

Cadalene, the important dehydrogenation product of some of the sesquiterpenes, was originally synthesised by Ruzicka and Seidel (*Helv. Chim. Acta.*,

1922, 5, 369) by a comparatively lengthy procedure. A new and much simpler procedure for its synthesis has been achieved.

p-Cymene was condensed with methyl succinic anhydride in presence of anhydrous aluminium chloride to give α-methyl-β-(*p*-cymoyl-2)-propionic acid, m.p. 118–119°, the structure of which has been established by a straight forward synthesis, starting from 2-acetyl-*p*-cymene.

The keto-acid was reduced by Clemmensen's method using Martin's modification (*J. Amer. Chem. Soc.*, 1936, **58**, 1438), yielding a colourless slightly viscous liquid, b.p., 182–85°/6 mm. The β-methyl, γ-(*p*-cymyl-2-)-butyric acid was cyclised with aluminium chloride, *via.*, the acid chloride to yield the corresponding tetralone, b.p. 136–138°/2 mm. The tetralone was reduced with sodium in moist benzene to give the secondary alcohol which was dehydrated with anhydrous formic acid. The resulting hydrocarbon, b.p. 132–138°/9 mm. was completely aromatised by dehydrogenation with selenium to give 1 : 6-dimethyl-4-isopropylnaphthalene or cadalene.

120. The Cyanine dyes of the Pyridine Series—Part VI.

M. Q. DOJA *and* KAILASH BIHARI PRASAD (Patna)

The influence of the presence of several *p*-dialkyl-amino-styryl groups on the sensitising power of a cyanine dye, has been studied. A new type of cyanine dye has been synthesised and examined, by the condensation of collidine methiodide with *p*-dimethyl—and *p*-diethyl aminobenzaldehyde.

121. Synthesis of Cyanine dyes by the condensation of *p*-di-ethyl-amino-benzaldehyde with appropriate heterocyclic compounds—Part IV.

M. Q. DOJA *and* JOGESH CHANDRA BANERJI (Patna)

Four new dyes have been synthesised by the condensation of *p*-di-ethyl-amino-benzaldehyde with 6-chloro-6-bromo, 6-methoxy-, 6-ethoxy-2-methyl benzothiazole-methiodides in absolute alcohol medium using piperidine as catalyst.

Their absorption spectra, sensitisation spectra and other properties have been studied.

122. Studies in Sulphonamides: Action of alkyl and aryl amine on benzene-1 : 4-disulphonyl chloride.

M. RAGHAVAN. B. H. IYER *and* P. C. GUHA (Bangalore)

In view of the increasing importance of sulphonamide type of compounds in chemotherapy, it was thought desirable to prepare a series of disulphonamides of the general formula $R\cdot NH{-}SO_2{-}C_6H_4{-}SO_2{-}NH\cdot R$, (para) where R is aryl or alkyl residue, and test the pharmacological activity of the compounds.

The action of benzene-1 : 4-disulphonyl chloride prepared according to the method of Drushel and Felty (*Amer. J. Sci.*, 1917, **43**, 57) on the following 24 amines has been studied and the products of reaction isolated and characterised. The amines used are methyl, ethyl, 2-pentyl, and isopropylpropyl-amines, ortho and para toluidines, ortho, meta and para xylidines, para-anisidine, *p*-phenetidine, *o*- and *p*-chloranilines, *m*-bromaniline, α and β naphthylamines, *p*-phenylenediamine, benzidine, *o*-tolidine, α-aminopyridine diaminodiphenyl sulphide and sulphone and phenyl hydrazine. The reaction was conducted in benzene and the products were crystallised from alcohol, acetone or water. All the products are soluble in dilute alkali. The therapeutic properties of these compounds are under investigation.

123. Action of aromatic hydroxy compounds on benzene-1 : 4-disulphonyl chloride.

M. RAGHAVAN, B. H. IYER *and* P. C. GUHA (Bangalore)

Carr and Brown (*J. Amer. Chem. Soc.*, 1947, **69**, 1170) have synthesised some *p*-alkoxybenzenesulphonic acid esters as possible local anæsthetics by reacting alkoxybenzenesulphonyl chloride with aliphatic alcohols (*cf.* Sen, *J. Ind. Chem. Soc.*, 1946, **23**, 383). With a view to study the pharmacological properties of benzene (1 : 4) disulphonyl esters, benzene-1 : 4-disulphonyl chloride has been reacted with 11 aromatic hydroxy compounds in acetone solution in the presence of sodium carbonate and the resulting sulphonyl esters have been isolated and characterised. The hydroxy compounds used are phenol, *o*- and *p*-nitrophenol, 2 : 4-dinitrophenol, *o*- and *p*-chlorophenols, *m*- and *p*-cresols, α and β naphthols and methone. Some of the reactions were repeated in presence of diethylaniline but the products were identical with the esters mentioned above. All the disulphonyl esters are crystalline compounds with definite melting points. The therapeutic properties of these compounds are under investigation.

124. Organo-arsenicals: Sulphonyl Esters of Hydroxyphenyl-arsonic Acids.

A. C. ROY, B. H. IYER *and* P. C. GUHA (Bangalore)

A number of arylsulphonamides have been prepared by the action of arylsulphonyl chloride on aminophenylarsonic acids and tested phramacologically (Hewitt, King and Murch, *J.C.S.*, 1926, 1365). A survey of the literature showed that very little study has been made of the compounds expected to be formed by the action of arylsulphonyl chlorides on hydroxyphenylarsonic acids.

Nineteen sulphonyl esters of the general formula $R \cdot C_6H_4 \cdot SO_2O \cdot C_6H_3 \cdot R^1 . AsO_3H_2$ have now been prepared by the action of (i) benzene-, (ii) *p*-toluene- (iii) *p*-chlorophenyl-, (iv) *p*-acetaminophenyl-, (v) β-naphthalene-, sulphochlorides on (*a*) 4-hydroxy-, (*b*) 3-nitro-4-hydroxy-, (*c*) 3-acetamino-4-hydroxy-, phenyl-arsonic acids, and characterised. They are under pharmacological examination. Some of these esters have been reduced to the corresponding arseno-compounds.

125. Studies in Rosin: Destructive Distillation of the Rosin from *Pinus excelsa.*

I. S. PATEL, B. H. IYER *and* P. C. GUHA (Bangalore)

The rosin from *Pinus excelsa* has been submitted to destructive distillation and a preliminary study of the gaseous and liquid products has been made. The gases evolved during distillation consist of carbon dioxide (64·1%), carbon monoxide (9·3%), oxygen (3·7%), hydrogen (7·0%), saturated hydrocarbons (13·0%), unsaturated hydrocarbons (2·9%). The crude distillate (75% on the weight of rosin) boiling from 80°–400° C. at ordinary pressure was collected into six primary fractions, which were further fractionated by redistillation at ordinary and reduced pressures. The physical constants like specific gravity, refractive index, optical rotation and viscosity of each of the fractions have been determined. Further work on the isolation and characterisation of individual compounds is in progress.

126. Studies in Antimalarials: Some Biguanide Derivatives.

H. L. BAMI, B. H. IYER *and* P. C. GUHA (Bangalore)

In continuation of the work on the synthesis of substituted biguanide derivatives as possible antimalarials (Bami, Iyer and Guha, *J. Indian Inst.*

Sci., 1946, **29 A**, I; *Indem*, *Curr. Sci.* 1947, **16**, 252, 254) some more compounds of this type have been prepared in order to test their antimalarial activity against avian malaria.

2 : 4-Dichlorophenylcyanoguanidine has been prepared by denitrogenating the azo-dye obtained after reacting 2 : 4-dichlorophenyldiazonium chloride with dicyandiamide, and reacted with hydrochlorides of dimethylamine, isoamyl amine and isopropyl amine to give N^1-2 : 4-dichlorophenyl-N^5-alkylbiguanide hydrochlorides.

Phenylcyanoguanidine has been reacted with 6-methoxy-2-aminobenzothiazole hydrochloride to give N^1-phenyl-N^5-6-methoxy-2-benzothiazolylbiguanide hydrochloride. Further work on the synthesis of compounds of these two groups is in progress.

127. Denitrogenation of Arylazocyanoguanidines.

H. L. BAMI, B. H. IYER *and* P. C. GUHA (Bangalore)

With the discovery of antimalarial action of substituted biguanide derivatives (Curd and Rose, *J.C.S.*, 1946, 729) and further work on similar lines (Bami, Iyer and Guha, *J. Indian Inst. Sci.*, 1946, **29 A**, 1; *Curr. Sci.*, 1947, **16**, 252), it is required to synthesise various substituted arylcyanoguanidines as important intermediates. These compounds have been previously reported by Walther and Greeshiemer [*J. fur. Prakt. Chem.*, 1915, **19** (ii), 218] and Wheeler and Jamieson (*J. Amer. Chem. Soc.*, 1903, **25**, 719), Walther and Greeshiemer's method has now been modified, extended and improved.

Curd and Rose (*loc. cit.*) have denitrogenated the triazines in a mixture of β-ethoxy-ethanol and hydrochloric acid, while we have denitrogenated *p*-chloroprophenylazocyanoguanidines and similar other *p*-substituted phenylazocyanoguanidines in a mixture of any of the following solvents and acids at 30°–40° in about an hour:

Solvents.—Formic acid, acetic acid, acetone, methyl-ethyl-ketone, diethylketone, ethylene-chlorohydrin, methyl alcohol, ethyl alcohol propyl alcohol and dioxan.

Acids.—Hydrochloric acid, hydrobromic acid, acetic acid, sulphuric acid and nitric acid.

It seems that the formation of a labile hydrochloride of the triazines is necessary, because it has not been possible to denitrogenate them by other methods without the use of acids. Failure to denitrogenate *p*-sulphamylphenylazocyanoguanidine also points towards a similar mechanism of reaction for such denitrogenations.

128. Studies in Antimalarials—Part I. Synthesis of some Methoxy-benzothiazole-carbamides.

P. C. GUHA *and* J. R. GUHA (Bangalore)

It has been found by workers in the domain of antimalarial drugs that compounds are most active when the methoxy group is in the position 6 of the quinoline ring and the nuclear nitrogen in the para-position to the methoxy group. Hence it was thought that compounds obtained by condensing various side chains to 2-amino-6-methoxy-benzothiazole may possess antimalarial properties, as benzothiazole may be considered as a quinoline ring in which two CH groups are replaced by a sulphur atom. The following urea and substituted urea derivatives of methoxy-benzothiazole have been synthesised:

1. $R.NH.CO.NH_2$, m.p. 330° (decomp.).
2. R.NH.CO.NH.Ph, m.p. 240°.
3. $R.NH.CO.NH.C_6H_4.OMe$ (*o*), m.p. 181°.
4. $R.NH.CO.NH.C_6H_4.OCH_3$ (*p*), m.p. 260°.
5. $R.NH.CO.NH.C_6H_4.CH_3$ (*p*), m.p. 236°.
6. $R.NH.CO.NH.C_6H_4.Me$ (*o*), m.p. 252°.

(R = 2-amino-6-methoxybenzothiazolyl)

129. Studies in Antimalarials—Part II. Synthesis of some 5-substituted thioureas and guanidines of 2-chloro-7-methoxy acridine.

P. C. GUHA *and* J. R. GUHA (Bangalore)

2 : 5-Dichloro-7-methoxy acridine is an essential starting material for the preparation of Atebrin. Guha and Mukherjee (*J. Indian Inst. Sci.*, 1946, **28 A**, Part IV, 70) prepared 5-diethyl-aminoisopentyl-substituted semicarbazido, thiosemicarbazido, hydrazino derivatives of 2-chloro-7-methoxy acridine compounds.

In the present paper is described the preparation of methyl, ethyl, phenyl-, *o*- and *p*- methoxyphenyl, *o*- and *p*-tolyl, thiocarbamido derivatives of 2-chloro-7-methoxy-5-amino acridine. They have been prepared by the action of substituted thioureas with the 5-amino acridine compound (R = methyl, m.p. 278–79°; ethyl, m.p. 287–88°; phenyl, m.p. 276–78°; *o*-methoxy, m.p. 282–84°; *p*-methoxy, m.p. 297–98°; *o*-tolyl, m.p. 293–94°; *p*-tolyl, m.p. 310–12°; *n*-propyl and *n*-butyl derivatives did not melt even at 360°.

Work is in progress for the conversion of these thiocarbamido derivatives into guanidine compounds by treatment of the alkylthiolthiocarbamides with suitable alkyl, aryl and heterocyclic amines.

130. Studies in Isolation, Estimation and Preparation of Derivatives of Cellulose.

P. S. VARMA *and* ABHAYA SINHA (Benares)

Cellulosic raw materials including bamboo, cotton waste, jute, hemp, flax, filter paper-cuttings, and cotton mill waste (broken, knotted threads, etc.) have been examined with a view to find out their cellulose contents and their suitability for the manufacture of synthetic fibres.

The α and β cellulose have been determined gravimetrically and the γ cellulose volumetrically. In some cases the γ portion has been found to exceed the β fraction.

Di- and Tri-acetyl, benzoyl and phthalate derivatives have been prepared and their properties examined. The acyl groups estimated quantitatively by the volumetric method—Eberstadt's method (*Ind.* and *Eng. Chem. Analytical* edition, 1941, **13**, 369).

131. Chemical Examination of the Flowers of *Bignonia venesta*.

PRITHWI NATH BHARGAVA (Benares)

A new wax ' Venestan ' (m.p. 66–79°) has been obtained from the benzene extract of the flowers of *Bignonia venesta*. It has been crystallised from methyl alcohol in brownish yellow flakes. Its saponification value has been found to be 141–47 and saponification equivalent, 378–96. As a result of hydrolysis some ceryl alcohol (m.p. 78°) and palmitic acid (m.p. 63°) have been isolated along with a minute quantity of the unsaponifiable matter which has been found to give Liebermann-Burchard's and Salkowski's colour reactions and hence showing the nature of a phytosterol. The work on the ' Phytosterol ' is in progress.

132. Halogenation—Part XXXXI. Direct Bromination of Aromatic Ketones.

P. S. VARMA *and* SATYENDRA VARMA (Benares)

In continuation of previous work (*Proc. Ind. Sci. Congress*, 1947) in which it was shown that some aromatic ketones could be directly iodinated and iodo-derivatives obtained by the methods of Varma and Panicker (*J.I.C.S.*, 1926,

3, 342), direct bromination of acetophenone, benzophenone, *p*-hydroxybenzophenone, *p*-methoxybenzophenone, *p*-aminobenzophenone, 4 : 4′–diaminobenzophenone, 4 : 4′-tetramethyl diaminobenzophenone, benzoin, benzil and anthraquinone have been carried on under similar conditions and good yield of bromo-derivatives obtained and some of them for the first time by direct bromination.

133. The characteristics and composition of vegetable fats in relation to the habit of the plant—Papilionaceæ family—Part II.

M. NARASINGA RAO *and* R SUBBIAH (Waltair and Vizagapatam)

Characteristics and composition of seeds from six members of the Papilionacaceæ family, namely: (1) *Erythrina Indica,* (2) *Pongamia glabra,* (3) *Sesbania grandiflora,* (4) *Arachis,* (5) *Psorulea corylifolia,* (6) *Trigonella fennugræcum* are examined critically and their relationship to the stature of the plant has been ascertained.

That the oils from seeds derived from trees are more saturated than those derived from herbs or shrubs within the close cycles of affinity has been observed in a previous paper in which the members of the Malvascæ family were chosen for examination. Herein, Papilionaceæ family, the members of which yield oil-bearing seeds is examined to find out the relationship between the habit of the plant and the characteristics and composition of the oil of its seeds.

134. Studies on Fries rearrangeement.

A. B. SEN *and* V. S. MISRA (Lucknow)

In the present paper, Fries rearrangement has been studied for the first time, in the case of purely unsaturated aliphatic acids. A number of phenolic-esters of Oleic and LB Hexenic acids have been prepared and their rearrangement on treatment with anhydrous aluminium chloride studied.

Oleic acid esters failed to give identifiable rearrangement products whereas six esters of Hexenic acid with phenol, *o*, *m* and *p*-cresol, Resorcinol mono-methyl-ether and hydroquinone mono-methyl-ether have been obtained. In the case of oleic acid however, only three esters, *viz.*, *o*, *m* and *p*-cresol oleate, have been prepared.

The LB Hexenic acid has been characterised by the preparation of the chloride and the amide.

Only the phenyl and *o*-cresyl esters, of Hexenic acid yielded a mixture of *o*-and *p*-hydroxyketones after the rearrangement, whereas the remaining esters formed exclusively the ortho-hydroxyketones. The ortho-hydroxyketones have been characterised by the preparation of their 2 : 4 dinitro phenyl hydrazones and the para-hydroxyketones through their benzoyl derivatives.

135. Search for new Insecticides allied to DDT—Part I.

A. B. SEN *and* P. M. BHARGAVA (Lucknow)

Two theories have been put forward concerning the remarkable insecticidal powers of dichloro-diphenyl-trichloroethane (*Nature*, August 11, 1945), One postulates that the toxic component is the linked *p*-chloro-benzene rings. while the chloroformic residue $-CCl_3$ imparts lipoid solubility (Lauger, Martin and Muller, *Helvetia Chim. Acta.*, 1944, **27**, 892). According to the other theory the lipoid solubility is attributed to the chlorobenzene rings, while the remainderof the molecule is responsible for toxicity by splitting of HCl at the vital centres (Martin and Wain, *Nature*, 1944, **154**, 512.)

The authors have synthesised a number of new compounds containing these two groups which are jointly responsible for the insecticidal properties

of DDT, with a view to determine the more exact relationship between chemical constitution and insecticidal properties.

The following new compound have been synthesises by condensation of chloral with the Grignard compounds of *p*-chlorobromobenzene, *o*-chlorobromobenzene and 1, 2-dichloro 4-bromobenzene respectively:—

1, 1, 1-trichloro 2-hydroxy 2-*p*-chlorophenyl ethane—brilliant yellow-liquid, b.p.—196–98°/11 mm., with characteristic smell. Colour fades on keeping.

1, 1, 1-trichloro 2-hydroxy 2-*o*-chlorophenyl ethane—brilliant red liquid, b.p.—196–98°/7 mm., with sweet smell.

1, 1, 1-trichloro 2-hydroxy 2-*m*-dichlorophenyl ethane—orange red liquid, solidifying to needles on cooling in ice. The colour gets discharged on keeping for a few months. Characteristic smell, b.p.—55–57°/5 mm.

The insecticidal action and physical properties of the abovementioned compounds are under investigation.

Bromination of chlorobenzene—It has been found that the bromination of chlorobenzene without using CCl_4 as a diluting agent gives a theoretical yield of *o*-chlorobromobenzene, while if chlorobenzene is diluted with an equal volume of carbon tetrachloride, the bromination is less vigorous and a theoretical yield of *p*-chlorobromobenzene is obtained.

136. Search for new Insecticides allied to DDT—Part II.

A. B. SEN *and* P. M. BHARGAVA (Lucknow)

The following new compounds have been obtained by the Friedel-Crafts' reaction between trichloracetyl chloride and chlorobenzene, *o*-dichlorobenzene and *p*-dichlorobenzene respectively:—

4-chloro 1-trichloroacetophenone—odourless black glistening plates from chloroform, insoluble in water, alcohol and ether, soluble in $CHCl_3$ and CCl_4. Does not melt.

3, 4-dichloro-1-trichloroacetophenone—light brownish-red liquid with characteristic smell. The colour begins to deepen immediately and in the course of few hours turns deep violet. Characteristic smell. b.p.—84–86°/36 mm., 80–81°/28 mm. This is obtained in a higher proportion than the ortho-isomer.

2, 3-dichloro 1-trichloroacetophenone—brilliant yellow liquid turning dark reddish-brown in course of time, b.p.—99–101°/22 mm.

3, 6-dichloro 1-trichloroacetophenone—yellow liquid, darkening on keeping. Characteristic smell, b.p.—120°/1 mm. *p*-dichlorobenzene is very soluble in this compound and the latter could be purified only after five fractional distillations in vacuum.

The insecticidal action and physical properties of these compounds are under investigation.

137. Search for new Insecticides allied to DDT—Part III.

A. B. SEN *and* P. M. BHARGAVA (Lucknow)

The following new compounds have been obtained by the direct condensation of trichloroacetyl chloride with the sodium salts of *p*-chlorophenol 2, 4-dichlorophenol and resorcinol respectively:—Ester of *p*-chlorophenol and trichloroacetyl chloride—light brownish-red liquid, b.p.—93–97°/2 mm., 95–100°/5 mm. Refracive index at 23°–1·5138.

Ester of *p*-chlorophenyl and trichloracetyl chloride—light brownish-red liquid, b.p.—93–97°/2 mm., 95–100°/5 mm. Refractive index at 23°–1·5138.

Ester of 2, 4-dichlorophenol and trichloracetyl chloride—colourless liquid which acquires a slightly brownish-tinge on keeping. Phenolic smell, b.p.—163°/0·5 mm., 167°/3 mm. Refractive index at 24°–1·5490.

Ester of resorcinol (both-OH groups substituted) and trichloracetyl chloride—colourless liquid with characteristic smell, b.p.—95°/5 mm.

The insecticidal action and physical properties of these compounds are under investigation.

138. Studies in Indigoid Dyes—Part V.

SISIR KUMAR GUHA (Patna)

In continuation of the work of Guha (*J. Indian Chem. Soc.*, 1935, **12**, 659; 1937, **14**, 709; 1938, **15**,/359, 1944, **21**, 391) on the studies of the influence of a methyl radical in the various available positions of the thionaphthene nucleus of bis-2-thionaphthene-ethylene-indigo, 2-thionaphthene-1′-aceanthrylene-indigo, benzylidene-2-thionaphthene and its *p*-nitro-, and *p*-dimethylamino derivative, the present investigation was undertaken.

7-chloro-2-hydroxy-thionaphthene (Dolgliesh and Mann, *J.C.S.*, 1945, 893) has now been condensed with glyoxal, aceanthrene-quinone, benzaldehyde, *p*-nitro-, and *p*-dimethyl-aminobenzaldehyde. The new substances are all beautiful crystalline coloured compounds. The dyeing shades on wool, obtained from all the products from an acid bath, have been fully and uniformly developed and those on cotton from the hydrosulphite vat have also been developed well in the case of bis-2-(7-chloro) thionaphthene-ethylene-indigo and 2-(7-chloro) thionaphthene-1′-aceanthrylene-indigo only.

139. Chemical Examination of the Nim Leaves (*Melia azadirachta*).

CHITTARANJAN MITRA AND SALIMUZZAMAN SIDDIQUI (Delhi).

As an extension of the work carried out on the Nim seeds (*Curr. Sci.*, 1942, 278; *J.S.I.R.*, 1945, **4**, 5), blossoms (*J.S.I.R.*, 1947, **6 B**, 19) and the root bark (*Proc. Ind. Sci. Cong.*, 1947), the leaves of the plant which are widely used for various skin affections, for the healing of unhealthy wounds and ulcers and also as a febrifuge, were taken up for investigation. Mature leaves collected locally in March were crushed after partially drying in shade and successively percolated with ether and then alcohol. The petrol ether insoluble fraction of the ethereal extractive yielded a water-insoluble amorphous bitter of an acidic character, melting at 90–110° C., (yield, 0·6 per cent. on the weight of the fresh leaves). The petrol-ether soluble fraction of the ethereal extractive yielded a sterol which did not show any depression in its melting point (137° C.). on admixture with nimbosterol (m.p. 137° C.) (*loc. cit.*). The carotenes present in this fraction could be separated from the sterol chromatographically. From the alcoholic extractive of the leaves an amorphous brown acidic product, soluble in hot water, has been obtained through its lead salt (yield, 0·2 per cent.). Further work is in progress.

140. Mechanism of Monomolecular Reactions.

B. PRASAD (Cuttack)

The simple Lindemann mechanism is defective as it postulates that the net rate of activation by collision is proportional to the concentration of active molecules. It has been suggested that the net rate of activation should be proportional to the difference between the theoretical and the actual concentration of active molecules. With this assumption it has been shown that if a molecule decomposes some time after activation the velocity constant would correspond to a unimolecular reaction if the concentration is not very low. At lower concentration the velocity constant would decrease and at still lower concentration when all the activated molecules will have a chance of decomposing before they are diactivated, the reaction would become bimolecular.

141. Chemical Investigation of the Seeds of *Adenanthera pavonina* Linn.

C. S. PATEL, C. C. SHAH *and* H. P. PARIKH (Baroda)

Seeds of the deciduous tree *Adenanthera pavonina* Linn. are used in India for medicinal purposes. Oil from these seeds has been analysed and found

to have sp. gr. 0·92, ref. index at 40° C. 1·477, acid value 2·43, sapn. value 190, iodine value 95·3, unsapn. matter 1·08%, Polenske value 0·77, Reichert-Meissl value 1·21. The alcoholic extract of the seeds contains a compound melting at 34° C. and is suspected to have an alkaloid.

Further work is in progress.

Biochemistry

142. Preparation of Amylose from Unmodified Starch.

P. N. JOSHI *and* K. V. GIRI (Bangalore)

A new method for obtaining amylose (a slight modification of Mac Cardy and Hassids method) has been standardised. The starch is leached out just below its gelatinisation temperature, and the extract is collected by centrifuging. To the clean extract, enough ethanol is added to give 40% concentration of ethanol by volume. Amylose gets itself precipitated within two or three days. This preparation is compared to the one obtained with Thymol as a precipitant. The extent of retrogradation, the kinetics of enzymic hydrolysis, and other factors have been studied.

143. Agar plate method for differentiation of various starch fractions.

P. N. JOSHI (Bangalore)

A method to distinguish between cereal and tuber starches as well as various amylolytic enzymes by using agar plate, as suggested by Giri was further extended to various starch fractions. A suitable explanation based on the differential rates of hydrolysis of the two fractions by various enzymes has been suggested to explain all the colour patterns.

144. Studies in the Fractionation of Soluble Starch.

P. N. JOSHI *and* K. V. GIRI (Bangalore)

Various methods of fractionation of starch were studied. It was possible to obtain amylose, amylopectin, and some other dextrin-like fractions in reasonably good yield. It was found that amylopectin and amylose were precipitated together, when fractionally precipitated with the precipitating solvents.

Even the so-called specific solvents gave a mixture of amylose and amylopectin. Suitable methods have been developed for the preparation of the two fractions. In the light of the above observations, the specific character of the above solvents, the inadequacy of the various methods used for determining and obtaining amylose, the heterogeneous character of amylose and amylopectin, and the mechanism of solubilisation are discussed in the paper.

145. Varietal Differences in Amylose and Amylopectin Contents of Rice Starch and their influence on the Quality of the Cereal.

A. R. VASUDEVA MURTHY, R. S. SUBRAMANYA *and* B. SANJIVA RAO (Bangalore)

The amylose and amylopectin contents of starch from twenty different varieties of rice were determined by the potentiometric titration method of Bates, as modified by Schoch. The swelling numbers of these varieties were determined by the method described by B. S. Rao (*10th International Congress of Chemistry*, Rome, 1938). A close correlation was found to exist between

the swelling number of a rice and the amylose content of its starch. Starch having 17% amylose was present in varieties of rice with superior cooking quality. Rice of poor cooking quality was found to have starch of low amylose content. A few varieties of rice had no amylose at all in their starch. Parboiling did not alter the amylose content of rice starch.

146. Studies on Groundnut Oil.

K. RAMA MURTI *and* B. N. BANERJEE (Bangalore)

A random collection of 25 samples of groundnut oil in Bangalore showed that the f.f.A. varied from 1 to 7% with an average from 3 to 4%. Generally, a deeper colour and flavour also indicates higher f.f.A., but the relationship is not directly proportional. Except in hydrogenation factories, the f.f.A. is not considered harmful. There are no limits of f.f.A. to debar consumption as human food though it is well known that rancid fats and oils destroy vitamins in the food and delay digestion and absorption. Ghani or Chekku oil is slightly better than expeller oil. Broken, mouldy and shrivelled grains raise the acidity of the oil 3 to 4 times. Roasting or steaming of the kernels before extraction of the oil nearly doubles the f.f.A. of the oil. The processes of neutralisation, clarification and decolourisation of the oil, improve the quality of the oil but not its storage quality. By careful screening and separation of broken, mouldy, and shrivelled kernels from healthy full size seeds, acidity below 1% can be obtained. Such an oil stores 3 to 5 times better than mixed oil from the same batch of seeds. While refining reduces the acidity below 0·2% acidity, it does not improve storage property. The natural anti-oxidant or inhibitol present in the seed is destroyed and f.f.A. increases on storage. Groundnut oil (unrefined, raw) with f.f.A. below 1% is the best for edible purposes. Oils of higher acidity should be earmarked for industrial purposes only.

147. Component Fatty Acids of Goat Milk Fat from Kathiawar.

SOMA KUMAR *and* B. N. BANERJEE (Bangalore)

A sample of goat-milk fat from Veraval (Junagadh, Kathiawar) has been analysed. On comparison with similar analyses, the effect of cotton-seed feed is evident A lower R.M. and high iodine value characteristic of cottonseed feed on cow and buffalo milk fat are observed. The results are interesting in that they confirm the data used for distinguishing, genuine cottonseed-area ghee from adulterated ghee.

148. The Composition of Papaya and Gooseberry Pectins.

C. R. KRISHNAMURTI *and* K. V. GIRI (Bangalore)

Pectins prepared from papaya (*Carica papaya*) and gooseberry (*Phyllanthus emblica*) by acid and ammonium oxalate extractions, were purified by dialysis, oxidation by bromine water and repeated precipitation with alcohol. The ash-free pectins were subjected to acid hydrolysis. Galactose and arabinose were identified in the hydrolysates. *d*-Galacturonic acid, the basal unit of pectic acid was isolated from barium galacturonate. From the yields of furfuraldehyde, mucic acid and the barium contents of barium galacturnates and barium pectates the structural units of the two pectins were calculated and were found to conform to the Nanji, Paton and Ling formula. consisting of 4 galacturonic acids, 1 of arabinose and 1 of galactose.

149. Prototropy and Antimalarial Activity.

U. P. BASU (Baranagar, Calcutta)

Different types of compounds—quinolines, acridines, guanidines, sulphonamides,—are now known to exert a chemotherapeutic action against malarial

parasites. Their behaviour against the plasmodium and the changes involved in their molecule tends to establish the fact that the activity of antimalarial drugs is derived from their ability to participate in an essential biological system of the parasite.

It is known that enzymatic reactions are virtually chemical in nature and would depend much on the mobility of the compound available for therapeutic action. The presence, or, the formation of a structure that allows prototropy for the existence of a mobile conjugated system seems to be responsible for the activity of a compound against malarial parasites. The sulphonamides and guanidines may belong to the former and the quinolines and acridines to the latter category. Sulphadiazine, mepacrine and quinoline are found to act through different mechanism. In the case of quinoline derivatives, only those that allow prototropic change for the formation of quinonoid structure, are active.

150. On the Determination of Arsenic in Pharmacopœial Arsenicals.

N. RAY *and* S. N. MITRA (Baranagar, Calcutta)

Various arsenical drugs are now used in clinical practice, but no single method has been fixed up for standardisation of their arsenic content. The method for arsphenamine as has been adopted in U.S.P. XII is often followed in determining the common pharmacopœial arsenicals but it is not suitable for sodium cacodylate. Further, it requires hydrogen peroxide which is not always available in standard quality.

In the present paper, methods of determining arsenic have been discussed. In the course of this work it has been shown that the U.S.P. XII Arsphenamine method may be followed in determining arsenic in carbarsone, sulfarsphenamine and sodium arsanilate even by replacing hydrogen peroxide by sodium oxalate. But a better and easier method for the determination of arsenicals whether pentavalent or trivalent would be the A.O.A.C. method that requires less chemicals and gives a correct indication of the arsenic content.

151. The Volatile Fatty acid Contents of Glycerin.

S. BHATTACHARYA (Baranagar, Calcutta)

Glycerin is largely used in pharmaceutical industries and for dietetic purposes. But the glycerin must be very pure. Several tests have been laid down in B.P. and U.S.P. in order to ascertain the purity of glycerine. Various brands of this chemical are now available in the Indian market ; but it is being noticed that one variety is superior to others in pharmaceutical preparations. The difference is being particularly noticed in the volatile fatty acid content. As there is no standard for the volatile fatty acid content of glycerine in any pharmacopœia, the cause and effect of its presence and the necessity of fixing its limit in pure glycerine have been discussed.

152. Nutritive Value of Travancore Fishes—Part I.

K. SADASIVAN PILLAI *and* N. S. VARIER (Trivandrum)

The nutritive value of the edible varieties of fish (indigenous to Travancore waters) with respect to their fat, protein and mineral contents is being determined as part of a dietetic survey. The present paper deals with the data obtained on the following six varieties: (1) *Arius sona* (Cat-fish), (2) *Thymus thynnus* (Tunny), (3) *Ophicephalus* sp., (4) *Lactarius* sp. (Butter Fish), (5) *Sphyralna acutipinnis*, (6) *Sciaena* sp.

Vitamins and trace elements are not determined in the present investigations.

153. Relation between toxicity and physical properties of antiseptics—Part I. Estimation of extremely dilute solutions of alkyl salicylic acids and *p*-alkyl phenols.

M. R. PAI, N. L. PHALNIKAR *and* B. V. BHIDE (Poona)

In an investigation carried out in this laboratory to correlate toxicity with physical properties of several alkyl salicylic acids and *p*-alkyl phenols, it was necessary to estimate accurately extremely dilute solutions of these substances in water. Usual volumetric procedure was found to be unreliable.

It was found, however, that potentiometric titrations could be carried out with advantage in the case of these substances and minute quantities of them could be estimated accurately.

Standard alkali was used for the potentiometric titration of the alkyl salicylic acids and brominating solution for that of alkyl phenols. The method has been checked by estimation of solutions of salicylic acids and phenols of known concentration.

154. Relation between toxicity and physical properties of antiseptics—Part II. Adsorption of alkyl salicylic acids and *p*-*n*-alkyl phenols.

M. R. PAI, N. L. PHALNIKAR *and* B. V. BHIDE (Poona)

The present communication deals with a study of the adsorption of alkyl salicylic acids and *p*-alkyl phenols on charcoal with a view to establish a relation between toxicity and adsorption.

The adsorption index ($1/n$) in Freundlich equation was expected to serve as a suitable function to represent adsorption but the Freundlich's isotherm has been found not to hold good accurately for the series of compounds studied.

The results are, however, discussed in relation to adsorption and the number of carbon atoms in the side chain.

155. Relation between toxicity and physical properties of antiseptics—Part III. Surface tension, adsorption solubility and toxicity of alkyl salicylic acids, alkyl phenols and alkyl resorcinols.

M. R. PAI, N. L. PHALNIKAR *and* B. V. BHIDE (Poona)

The physical properties such as surface tension, adsorption on casein and solubility of alkyl salicylic acids, alkyl phenols and alkyl resorcinols have been studied in the present work.

The toxicity of these compounds towards earthworms has been determined in aqueous solutions of equimolecular concentrations.

It has been shown that there is no relation between toxicity and ability of the members of a series to lower surface tension as also their adsorption by casein.

It has been found that adsorption plays a more important part in determining toxicities of the higher members of the series while there is no correlation between the lower members of the series. There is no parallelism between the water solubilities of the compounds and their toxicities.

It is, therefore, believed that probably the mechanism of bactericidal action of the higher members of the series which are sparingly soluble is quite different from the mechanism of the bactericidal action of the more soluble members of the series.

156. Tamarind seed Jellose: Fermentative Degradation.

P. S. Rao (Dehra Dun)

Tamarind seed jellose undergoes fermentative degradation in aqueous solution, yielding a hexasaccharide, which is composed of xylose, galactose and glucose. The sugar, which may be named Tamarindose, decomposes at 228–30° C. and has a specific rotation of 73·8°. Its acetate melts with decomposition at 172–74° C. and has a specific rotation of 41·2° in methyl alcoholic solution.

157. Progress of Proteolytic Digestion of Commercial Casein with Papain.

M. M. Biswas (Calcutta)

Commercial casein of standard quality has been subjected to proteolytic digestion by papain at pH 5·0 in presence of sodium thiosulphate and 8-hydroxy quinoline. Conductometric titrations have been carried out with 20 c.c. of digestion mixture at certain intermediate stages of the enzyme reaction with N alkali. Corresponding pH values have also been recorded. Titration curves drawn from these data indicate that the capacity for H ion adsorption by the digestion mixture falls at first with the progress of proteolytic digestion. The ionic equilibrium in the reaction mixture is not materially changed during the period of digestion.

158. Standardisation of Indian Ox Bile by its Refractive Index.

U. P. Basu *and* N. Ray (Baranagar, Calcutta)

In the different slaughter houses of India more than 3·25 lakhs of cows and buffaloes are annualy slaughtered. The determination of the refractive index and other physical properties of the bile collected from the gall bladders of the slaughtered animals (*cf.*, Basu *et al.*, *Ind. Med. Gaz.*, 1940, **75,** 215) throughout the year indicates that about 25 per cent. of these animals do not yield bladders rich in good quality bile. The yield of cholic acid from better grade bladders is about 18 g. per litre while that from the lower grade bladders is not more than 6 g. per litre. On an average one litre of bile is available from four gall bladders. A considerable amount of bile can therefore be collected during the year to afford sodium tauroglycocholate and other bile acids and salts. It has been noticed that bile exhibiting a refractive index of 1·3410 or lower than this, is not suitable for economic utilisation. The question of renovation of the slaughter-houses, the method of utilisation of the bile and the amount of various products that are available, have been discussed in the paper.

159. On the Iodometric Estimation of Vitamin C in Pharmaceutical Preparations.

S. K. Ganguly (Baranagar, Calcutta)

Vitamin C is now being added to various pharmaceutical preparations containing syrup, alcohol and glycerin. The simple method of iodometric titration may be followed in assaying the vitamin C content of preparations made up with syrup, alcohol or glycerin. If vitamins A and D be present the above assay may also be followed, but the elixir should be adjusted to pH 0·02 to 0·08 with sulphuric acid and the double back titration method of Stevens (*Jour. Ind. Eng. Chem.*, 1938, **10,** 269) should be adopted.

160. Ascorbic acid as an analytical reagent for Iron—A preliminary note.

E. K. NARAYANAN (Calcutta)

The quantitative estimation of iron in the presence of much invert sugar and phosphoric acid is beset with difficulties. The official process for the estimation of iron in pharmaceutical preparations such as Syrupus Ferri Phosphati and Syrupus Ferri Phosphati cum Quinina et Strychnina is to titrate the solution, after oxidising the iron to the ferric state, against standard titanous chloride solution using ammonium thiocyanate as an internal indicator. Due to the un-availability of titanous chloride an alternative process has been devised using ascorbic acid. The iron content of five standard preparations of Syrupus Ferri Phosphati cum Quinina et Strychnina estimated by the new method ranged from 90·2 to 104·4% of the theoretical value calculated from the formula, but these are within the range of variability allowed by B.P. for processing. Further work is planned to increase the agreement between duplicate titrations, wihch is only 5% at present.

161. Stabilisation of solutions of Calcium Gluconate for injection.

E. K. NARAYANAN (Calcutta)

Calcium gluconate which dissolves only to about 4% in water at atmospheric temperatures, is required by the medical profession in 10 and higher percentage concentrations. For achieving this end, either expensive brands of the compound which readily give solutions of high concentrations are employed or use is made of certain substances as stabilisers. The chemical background of the stabilisation is not explained in literature. A study has been made of the reaction of one such stabiliser, *viz.*, boric acid, with various polyhydroxy compounds such as sucrose, lactose, maltose, ascorbic acid, glucose, mannose and calcium gluconate and it has been found that the chemical influence, as shown by the acidity, does not bear any relationship with the richness of the compound in hydroxyl groups. Calcium gluconate, however, forms a highly acidic solution. The solubility of this compound in various concentrations of boric acid, the titratable acidity of the solutions in relation to their equivalence to the boric acid present and other aspects have been studied. The titre value to pH 8·2 is only slightly in excess of that required by a monobasic acid. The concentration of boric aicd optimally profitable for making injections has been found to be 0·5%, when 8·0% of calcium gluconate dissolves by mere mixing at room temperature. Neutralisation of such a solution by calcium carbonate yields a solution therapeutically richer in calcium, within B.P. standards.

162. Preparation of Coir from dried Coconut Husks.

P. N. JOSHI *and* K. V. GIRI (Bangalore)

It is possible to obtain coir from dried coconut husks by treatment with steam under pressure. Coir, thus obtained, is however black and attempts were made to find out if the tannin-like constituents soluble in alcohol are responsible for the blackening of the coir. Treatment with 0·20% Hydrochloric acid solution prevents the blackening and at the same time helps in softening the husk. The effect of concentration of acid, the time of keeping, the nature of acid, and the temperature of reaction mixture on the process, were investigated.

Brown coir of good quality can be obtained by the above method.

163. Manufacture of Ultramarine Blue.

A. L. SUNDARA RAO *and* D. S. TANDON (Delhi)

The optimum conditions for the manufacture of ultramarine blue have been worked out. The samples obtained have been compared against the the standard products obtained in the market—the 'pigment' value or 'blue' of the ultramarine being estimated by the time required to decolourise by a known amount of standard acid. Though this is a rough method it is a ready and the only qualitative method of estimating the amount of ' blue ' or ' quality ' of any sample. The time of decolourisation values, as measured in seconds, obtained for different samples are:—

Standard 67: Sample No. 1, 55; Sample No. 2, 90; Sample No. 3, 137.

Samples No. 1, 2 and 3 are all pure samples of ultramarine without any diluents such as gypsum, chalk, barytes, etc., which are generally used in commercial samples.

Experiments are in progress to use the indigenously occurring Kaolin. Bentonite and other naturally occurring earths for the manufacture of ultramarine.

164. Component Fatty Acids of Buffalo-Milk Fats.

D. R. DHINGRA *and* GANESH CHANDRA (Kanpur)

Component fatty acids of buffalo milk fats obtained from Punjab in early and late lactation periods have been examined and it is found that the milk fat of early lactation period contains butyric 2·61, Caproic 0·70, Caprylic 0·99, Capric 1·76, Lauric 8·04, Myristic 11·60, Palmitic 28·55, Stearic 9·14, Archidic 4·31, Oleic 32·21 and non-saponifiable matter 0·09. The milk fat of late lactation period contains Butyric 2·08, Caproic 0·93, Caprylic 0·72, Capric 0·68, Lauric 4·27, Myristic 14·39, Palmitic 31·63, Stearic 5·45, Arachidic 2·02, Oleic 34·17, Linoleic 2·39, C_{20}–C_{22} 0·23, and non-saponifiables 0·04.

Ghee from early lactation period contains more butyric acid and other steam volatile acids (Butyric to Lauric) than that from late lactation period while the content of unsaturated acids is less in the former. Obviously, lower fatty acids and unsaturated acids seem to take the main part in the metabolism of milk fat and seem to be exchangeable in their functions, at different periods of lactation.

Ghee from early lactation milk possessed higher Reichert value and better buttery flavour than that from late lactation period.

Higher content of butyric acid in C.P. milk fat (analysed by Bhattaacharya and Hilditch) and lower percentage of lauric acid in it as compared with Punjab milk fats are unusual. From the content of the unsaturated acids and percentage of other acids in general it seems that C.P. milk fat resembles more, early lactation fat. Differences may be due to climatic differences (the temperature of C.P. is usually about 5 to 10° higher than that of North-West of Punjab in October) and some food differences. However, differences in component fatty acids are not very great.

Butter-fat of early lactation period is superior to that of late lactation period in respect of odour, flavour and fatty acid content.

Industrial Chemistry

165. Chemical Study of Mango Kernels (Tukhmi Dessi).

D. R. DHINGRA, S. N. KAPOOR *and* GANESH CHANDRA (Kanpur)

The kernels of Tukhmi (Dessi) mangoes contain Fat 10·7%, Starch 72·8%, Sugar 1·07% Protein 9·5%, Tannins 0·11% and Ash 3·66% (1·3% potassium oxide, 0·28% sodium oxide and calcium, magnesium, iron and sliica in small quantities). Ash does not contain any aluminium.

From the analysis it is concluded that they form a good substitute food-stuff for domestic animals as confirmed by Kehr. In samll doses it can also be mixed with wheat flour for human consumption and it can solve to some extent the acute shortage of food.

The component fatty acids of mango kernel fat consist of Capric 0·15, Lauric 2·74, Myristic 5·07, Pamitic 11·2, Stearic 31·06, Arachidic 1·71, Oleic 43·83, Linoleic 4·13 and unsaponifiable matter 0·1. These results materially differ from those given by Godbole *et al.* (*J. Ind. Chem. Soc.* 1946, **23**, 407).

The practicability of using the fat in the manufacture of soap is discussed. Uses for the meal are indicated.

166. A New Process for the Manufacture of Santonin.

S. K. SAHA (Calcutta)

A simple and economic method has been developed by which Santonin is prepared from *Artimisia maritima* on a commercial scale. Artimisia is mixed up with straw and thoroughly moistened with water and extracted with benzene in a Soxhlet. The extract is taken up with lime water and gives on treatment with hydrochloric acid crude Santonin. This is purified by treatment with dilute soda solution and finally recrystallised from dilute alcohol. Yield is 90–95%.

167. Investigations on Some Cellulose bearing Raw Materials (other than Cotton) for the Manufacture of Rayon.

M. G. KARNIK *and* D. L. SEN (Matunga, Bombay)

Cellulose bearing raw materials available in India were studied as possible sources for the manufacture of rayon and allied products. Pulps obtained in India by the Soda, Sulphate and Sulphite processes were tested for their alpha-cellulose and ash content, cuprammonium viscosity, solubility in 1% alkali, lustre, copper-number and other factors.

A new technique has been evolved to isolate cellulose from bagasse which is a potential source of cellulose having characteristics similar to the pulp used in the rayon manufacture.

Pulps from bamboos, reeds, bagasse, etc., were studied from the stand-point of viscose and cellophane production.

168. Manufacture of Stearic Acid from Indian Vegetable Fats (*Garcinia indica*).

C. J. DASA RAO (Waltair)

Commercial raw material for the manufacture of stearic acid is animal fat (Tallow) and the product obtained is always contaminated with other fatty acids. A method for the preparation of stearic acid from vegetable fats (*Garcinia Indica*) has been worked out and gives chemically pure stearic acid. It consists in hydrolysing the vegetable fat with alcoholic potash by refluxing for 3 to 5 hours. After the hydrolysis is complete the alcohol is distilled off and the soap suspended in water. The suspension is treated with the required quantity of sulphuric acid, the mixed fatty acids liberated are separated from the aqueous layer. The mixed acids are dissolved in the minimum quantity of hot 95% alcohol and allowed to cool. Pure stearic acid crystalise out leaving palmitic and liquid acids in solution.

The commercial possibilities of the process are being worked out.

169. On the Electrical Coagulation of Cane Juice Colloids.

D. N. GHOSH (Patna)

The present paper is a continuation of the work communicated previously (*Proc. Indian Science Congress*, 1947). The process has since been tried on a large scale in the Guraru Factory of the Gaya Sugar Mills Ltd. and a comparative study, of the economics and the various stages of the Electrical, Double Carbonation and Double Sulphitation processes for sugar making, has been made.

170. Dielectric Constants of Plastics.

S. K. K. JATKAR *and* B. R. Y. IYENGAR (Bangalore)

The dielectric constants and density data of polyvinyl chloride, polychloro styrene, glycol phthalate, polyvinyl chloroacetate, vulcanized rubber, methyl methacrylate, polysiloxanes, '*w*' hydroxy-decanoic acids, acetonitrile-ethyl acrylate copolymers and solutions of polyvinylchloride, methylmethacrylate, mono and polychloroprene, mono and polystyrene, acetyl-, benzyl- and nitro-celluloses have been quantitatively interpreted on the basis of molecular structure. The effect of plasticisers and solvents on the various polymers has been explained quantitatively.

171. Dielectric Constant of Cellulose.

S. K. K. JATKAR *and* D. S. SASTRY (Bangalore)

The high dielectric constant of cellulose has been quantitatively interpreted on the basis of the new equation to mean rotation of the cellobiose units in the same sense as in solid HCl, HBr and Camphor. The moment so calculated is the vector of two C–O links with bond moment of 1·75 D.

172. Dipole Moment of Cellulose Esters.

S. K. K. JATKAR *and* D. S. SASTRY (Bangalore)

The dipole moment for a cellobiose unit for different degrees of nitrated cellulose has been measured in the acetone, ethyl, butyl and amyl acetate esters at different temperatures and frequencies. The moments calculated either by the D.C.M. equation or by the new equation show highly anomalous variation of the moment with degree of nitration, reaching high values when odd number of the six hydroxyl groups of cellobiose gets nitrated and low values which are nearly the same as for the original cellulose, when an even number is nitrated. These results definitely support the cellobiose structure of cellulose, the esterification proceeding in the order 6, 6′, 3, 3′ and 2, 2′. Some of the middle stages are mixtures of lower and high esters, the corresponding HCOH groups being in transposition. A study of previous work on the dielectric constants of ethyl, benzyl, acetyl and palmityl cellulose on the basis of the newer theories confirms the above findings.

173. Optical Activity of Cellulose and its Esters.

S. K. K. JATKAR *and* D. S. SASTRY (Bangalore)

The optical activity of the different derivatives of cellulose goes hand in hand with the dielectirc polarisation and dipole moments. The highly anomalous nature of the optical activity with different degrees of esterification and hydrolysis shows six steps and not three.

174. Tannic Acid a by-product in the manufacture of Caffeine from Tea-waste.

Hara Gopal Biswas (Calcutta)

A laboratory method for the preparation of pure tea-tannin has been described. The constitution of the tea-tannin has been briefly discussed. A method of recovery of tea-tannin suitable for the preparation of writing ink from a charge of tea-waste used in the manufacture of Caffeine has been given. Experiments are in progress for the recovery of tea-tannin from the exhausted mass of the usual methods of manufacture of Caffeine from tea-waste.

175. Preparation of Benzene Hexachloride or 666.

D. R. Dhingra, S. N. Kapoor *and* R. P. Agrawal (Kanpur)

The paper gives in detail the method of preparation of pure gammexane from Benzene and Chlorine. Five isomers namely α, β, γ, δ and ϵ are formed out of which γ isomer is the most powerful insecticide against carpet beetles, cloth moth flies, silver fish and ants, etc. It contains 73% chlorine.

Gammexane is prepared by passing chlorine into a reaction mixture consisting of 10% caustic soda solution and benzene in presence of catalyst, *e.g.*, antimony and mercury. The reaction mixture was continuously stirred and the temperature was kept at 20–25° C. The absorption of chlorine is most satisfactory when the reaction mixture is alkaline.

The authors have tried various catalysts and conclude that mercury either alone or in combination with antimony gives the best yields. Catalyst containing 4 of antimony to 1 of murcury gives the highest yield of γ isomers (19·4%) as compared with 12% so far reported.

Details of equipment and the cost of manufacture of Gammexane are given.

176. On the Manufacture of Potassium Chlorate.

U. P. Basu, S. Mukherjee *and* S. Bhattacharya (Baranagar, Calcutta)

The economics of the manufacture of potassium chlorate in India is discussed. Potassium chlorate can be produced by a modified process at one rupee per pound in India while the imported chemical costs three rupees per pound.

177. Furfural Plastics.

S. Ranga Iyengar (Bhadravathi)

Results obtained at Bhadravahi with a pilot plant for the manufacture of furfural and furfural plastics from agricultural waste materials rich in pentosans are discussed. Optimum conditions for the manufacture of furfural were determined.

Experiments were directed to obtain thermosetting moulding compositions similar to Bakelite (70) in an existing Pilot Plant manufacturing Phenol-Formaldehyde synthetic resins and moulding powders on a production basis. Equimolecular proportions of furfural and phenol were condensed in presence of different catalysts to obtain the desired resin. Only basic catalysts were found suitable and a 3·5% sodium hydroxide as 20% solution was found most suitable from the standpointof increased output and reduction of time of reaction. The yield of resin is nearly two times and that of moulding powder more than four times the furfural used. Moulding compositions

prepared are thermosetting, and have good flow. The articles take a fine polish.

Furfural-phenol and furfural-cresol plastics resemble Bakelite but are either black or dark brown in colour even without the addition of dyestuffs and take a relatively longer time for curing. The curing time has been reduced to 3·5 minutes at 145–50° C. Tests conducted on moulded articles are described. Further tests to standardise Furfural powders are under way. Experiments are being conducted to find out other uses for this versatile aldehyde.

178. The Iodine Content of Indian Sea-weeds.

ITTYERAH JOSEPH (Trivandrum)

Estimation of iodine was made on various samples of Indian sea-weeds collected at different parts of the year and from different places in India. It appears from the collected data that the iodine content of weeds is higher during the colder months (January to March) than during the hotter months (July–August).

179. Antioxidants for Shark Liver Oil—Part X. Influence of certain Hormones, Phenolic Compounds, Synthetic Dyestuffs and Essential Oils on the stability of Shark Liver Oil.

P. K. MATHEW, P. V. NAIR *and* T. A. RAMAKRISHNAN (Trivandrum)

Substrates of saw fish liver oil and tiger shark oil have been employed for determining their response towards common antioxidants. The hormones which had practically no effect in saw fish oil in mild concentration have been found to evoke a greater response from tiger shark oil.

Among the essential oils tried for their antioxidant properties—cinnamon leaf oil, cardamom oil, oil of pepper, oil of ginger, oil of *Ocimum gratissimum*, lemon grass oil, oil of nutmeg, cloves and peppermint—none of them seems to have any effect on the stability of either tiger shark or saw fish oil.

Naphthol dyes are indifferent in their activities while alizarin had pronounced pro-oxidant influence on substrates of both the oils.

Quinhydrone and α-naphthol were found to have relatively high antioxidant properties whereas *o*-cresol and phenoquinone were only feebly antioxygenic.

180. Antioxidants for Shark Liver Oil—Part XI. Influence of some Organic and Inorganic Acids and some Organic Substances on the stability of Shark Liver Oil.

P. K. MATHEW, P. V. NAIR *and* T. A. RAMAKRISHNAN (Trivandrum)

A substrate of tiger shark liver oil remained practically unaffected by the addition of 0·1% of its weight of 20% sulphuric acid while on the same substrate orthophosphoric acid was observed to have a mild antioxygenic activity and hydrochloric acid, if anything, a prooxidant tendency.

Malic acid and hippuric acid which were tried as probable antioxidants furnished indifferent results on pristis oil and on other trade samples of shrak liver oil while β-indolyl acetic acid (hetero-auxin) showed definite pro-oxidant tendency.

Among the miscellaneous organic substances tried—Purpurogallein Phenolphthalein, Gammexane and Sodium taurocholate—purpurogallein alone had pronounced antioxidant activity which is presumably due to the pyrogallein group present in its molecule,

181. Alginic Acid from Sargassam Sea-weeds of the Travancore Coast.

K. SADASIVAN PILLAI *and* N. S. VARIER (Trivandrum)

Sargassam sea weeds are obtainable in considerable quantitites from the rocky coast-line extending from Cepe Comerin to Kovalum. The optimum conditions for obtaining alginic acid have been worked out. The use of sodium and ammonium alginates in the creaming of rubber latex has also been investigated.

182. Building Lime Industry in Travancore.

R. KRISHNA PILLAI (Trivandrum)

Lime shells collected from the backwaters and coastal tracts in Travancore are extensively used in the production of building-lime. In spite of the crude methods employed, the industry is believed to give profitable returns. The country kiln which involves very considerable heat losses, the insufficient adjustment in the proportion of shell and fuel and the poor quality of the shells themselves often account for the low CaO content of the burnt lime.

Several samples of lime shells collected from different parts of the State have been analysed and their CaO contents found to vary from 49–54%. The CaO content of the burnt lime obtained from different kilns was however found to be 24–40%.

183. Minor Forest Products of Travancore—Part I. Furfural from Wood Wastes.

C. S. BHASKARAN NAIR, P. V. NAIR *and* M. SREEDHARAN PILLAI (Trivandrum)

The wood wastes from twelve varieties of timber and fuel wood trees indigenous to Travancore have been subjected to examination with a view to utilizing them in the manufacture of furfural. Distillation with 12% HCl without pretreatment afforded results varying from 7·15% furfural with *Terminalia paniculata* Roth to 13·15% with *Tamarindus indica*. Experiments in improving the yield with hypobromite and other suitable pretreatment are in progress.

184. Minor Forest Products of Travancore—Part II. Composition and Processing of Forest Honey.

P. V. NAIR, M. SREEDHARAN PILLAI *and* K. S. MADHAVAN PILLAI (Trivandrum)

Representative samples of forest honey collected by the Travancore Forest Department have been analysed and compared with apiary honeys and the so-called medicinal honeys. The observed variations in the chemical composition between forest and apiary honeys are inconsiderable. The differences attributed to their nutritional efficiency are presumably due to subtle variations in their invertase and diastase activity and to the presence of microquantities of characteristic colloids.

A convenient method for the processing of forest honey in Travancore has been recommended.

185. Minor Forest Products of Travancore—Part III. *Spatholobus roxburghii* and *Myristica attenuata* resins.

K. N. Gopinathan Nair, P. V. Nair *and* (Miss) P. Saradamma
(Trivandrum)

The transparent, ruby coloured gum which exudes from the barks of *Spathalobus roxburghii* (N.O. Leguminoceæ) furnished a tannin which on fusion with potash yielded catechol. Its methyl and acetyl derivatives have been prepared. *Myristica attenuata* (N.O. Chloranthaceæ) resin contains a catechol tannin whose methyl and acetyl derivatives have been prepared. Tinctorial experiments with these dyes are in progress.

186. Minor Forest Products of Travancore—Part IV. *Parkia biglandulosa* bark.

(Miss) T. Pankajakshy Amma, P. V. Nair and T. V. Punnoose
(Trivandrum)

Parkia biglandulosa (N.O. Leguminaceæ) barks have been used for tanning and dyeing purposes. The purified tannin gave catechol on fusion with potash and the characteristic reactions of phlobatannins. The methyl and acetyl dervatives have been prepared. Tinctorial experiments with the dye on mordanted cotton hanks are in progress.

187. Minor Forest Products of Travancore—Part V. *Sterculia urens* resin.

P. V. Nair, M. Sreedharan Pillai *and* K. S. Madhavan Pillai
(Trivandrum)

Sterculia urens Roxb. (N.O. Sterculiaceæ) grows wild in the Travancore forests and its stem exudes a rather plentiful resin. The tannin matter isolated from the resin gave catechol and protocatechuic acid on fusion with potash and for the most part consists of a phlobatannin as proved by its reactions. Its methyl and acetyl derivatives, both of which have been prepared, have showed the existence of three OH-groups.

Tinctorial experiments with the extracts of the dye on mordanted cotton hanks afforded a variety of pleasing shades, all of which were shown to be fairly fast to light and soapwash.

188. Studies in the Technology of Shark Liver Oil—Part VI. The Bellier Figure as an Index of adulteration of Shark Liver Oil with Groundnut Oil (Contd.).

P. K. Mathew. P. V. Nair *and* T. A. Ramakrishnan
(Trivandrum)

In Part II of this series (*Abs. Proc. I.S.C.*, 1947), the authors had indicated a line of approach to a "rough and ready" method for the determination of the percentage of adulteration in market samples of shark liver oil with groundnut oil. Over thirty samples of fresh and rancid shark liver oil drawn from different species of fish were examined and it was generally observed that fresh oil returned values varying between 23 and 24 while rancid oil gave slightly higher results but never exceeding 25·2.

The iodine value of the oil does not bear any relation to the Bellier Figure, which appears to be constant within a narrow range as long as the oil is homogeneous. Partial destearination of the oil effects hardly any lowering in the Bellier Figure. The relation between the Bellier Figure and the percentage of groundnut oil added can be represented in the form of a smooth curve,

189. Studies in the Technology of Shark Liver Oil—Part VII. Optimum pH for the Enzymolysis of Shark Liver Oil with Castor Seed and Pancreatic Lipases.

P. V. NAIR, T. A. RAMAKRISHNAN *and* H. SREEMULANATHAN
(Trivandrum)

Qualitative observations on the comparative efficiency of ricinus and pancreatic lipases in the enzymic hydrolysis of shark liver oil were made in a previous communication (*Abs. Proc. I.S.C.*, 1947). Lypolysis was effected on the same sample of shark liver oil both with castor seed powder in acetate buffers (pH 3·9–5·4) and with pancreatic extract activated with sodium taurocholate (M—10,000) in borate buffers (pH 8–10). Under the conditions studied, the optimum pH for the lypolytic action of castor seed lipase has been found to be 4·2 (*ca*) and that of pancreatic lipase to be 8·8.

190. Studies in the Technology of Shark Liver Oil—Part VIII. A Comparative Study of the Progress of Enzymolysis in Shark Liver Oil and other Edible Fats with Pancreatic Lipase.

P. V. NAIR, T. A. RAMAKRISHNAN *and* H. SREEMULANATHAN
(Trivandrum)

The degree of lypolysis of shark liver oil with pancreatic extract has been compared with those of coconut oil, sesame oil, ghee and vanaspati under identical conditions of experiment. The digestibility of these fats as revealed by the progress of lypolysis under standardized laboratory conditions has been found to be in the order given:—coconut oil, sesame oil, vanaspati, ghee, shark liver oil.

191. Studies in the Technology of Shark Liver Oil—Part IX. Progress of Enzymolysis in Shark Liver Oil and other Edible Fats with Castor Seed Lipase.

P. V. NAIR. T. A. RAMAKRISHNAN *and* H. SREEMULANATHAN
(Trivandrum)

The degree of hydrolysis in shark liver oil and other edible fats such as coconut oil, cow's ghee, buffalo ghee, sesame oil, vanaspati and beef tallow with a uniform preparation of castor seed lipase was followed by the titrimetric method. It was observed that there was appreciable parity between the initial rates of breakdown in all the substrates. The digestibility as revealed by the degree of hydrolysis decreases progressively from coconut oil to beef tallow in the order stated:—Coconut oil, cow's ghee, buffalo ghee, sesame oil, vanaspati, shark liver oil, beef tallow.

192. Studies in the Technology of Shark Liver Oil—Part X. Degree of Enzymolysis in Shark Liver Oil of Varying Origin and in Adulterated Shark Liver Oil.

P. V. NAIR, T. A. RAMAKRISHNAN *and* H. SREEMULANATHAN
(Trivandrum)

The action of castor seed lipase on substrates of shark liver oil collected during different seasons and from different species of sharks was followed by the usual method under standardized conditions of experiment. It was expected that the result would, furnish an insight into the comparative digestibility and consequently of the therapeutic and nutritional efficiency of the

oils; and, provide a suitable basis for the blending of these oils in manufacturing practice.

Although the seven samples of oil subjected to lypolysis had divergent physical and chemical characteristics, their response to lipase was found to be nearly the same. The " Hydrolytic Index " could be successfully applied to the detection of adulteration in trade samples of shark liver oil which are usually blended with varying proportions of groundnut oil. Laboratory tests with known mixtures of shark liver oil and groundnut oil have confirmed this conclusion.

193. Studies in the Technology of Shark Liver Oil—Part XI. Halogenation of Deoxygenated low grade fish oils.

(MISS) K. PANKAJAKSHY AMMA, P. V. NAIR *and* T. A. RAMAKRISHNAN (Trivandrum)

Low grade shark liver oils which are poor in vitamin content find use at present, only for caulking boats. On deoxygenation with zinc dust, the oils could be made to yield a product containing nearly 98% hydrocarbons. The reduced product was chlorinated under varying conditions. On subsequent fractionation at a temperature range of 100–170° C. (45 mm.) and estimation of the chlorine content of each fraction it was observed that the fraction collected between 128–145° C. contained as much as 23% chlorine. Alcoholic potash liberates about 14·2% of the chlorine from this fraction, while aqueous potash releases 2·8% and boiling water 0·96%.

The insecticidal properties of the chlorinated products are being investigated.

194. Travancore Marine Oils—Part IV. Physical and Chemical Characteristics of Shark Liver Oils.

P. K. MATHEW, P. V. NAIR *and* T. A. RAMAKRISHNAN (Trivandrum)

The physical and chemical constants of several samples of liver oils drawn at the Government Shark Liver Oil Factory, Trivandrum, from *Stegostoma tigrinum* and *Pristis cuspidatus* have been determined. Considerable variations in the initial physical and chemical characteristics have been observed with oils expressed from the same species of fish.

195. Nitro-Cellulose in Peace and War.

S. K. K. JATKAR *and* D. S. SASTRY (Bangalore)

Nitrocellulose has come to stay in explosives, plastics and lacquers. The properties of the lower nitrates containing less than 10% nitrogen and their utilisation is being studied with new types of plasticisers of the vinyl acetate type. Mixed esters of the nitro-acetyl type whose properties will be different from both the nitro- and acetyl-esters will also find increasing applications. With advances in manufacturing processes and discoveries of new usages for this material it will still play an important role in the service of humanity.

196. Performance of the secondary milling unit in Sugar Factories.

K. S. GURURAJA DOSS (Cawnpore)

Several expressions have been proposed from time to time for comparing the performance of the secondary milling units. The defects in these have

been pointed out. The following new scheme based on the theory of milling formulated by the present author has been shown to be the best for the purpose:—

(i) Calculate the secondary juice extraction by the formula

$$e_s = \frac{J_s\, g_s}{g_p\,(1 - f)}, \text{ where } J_s = J_m \frac{g_p - g_m}{g_p - g_s}$$

(ii) Calculate R'_v by the formula

$$R'_v = \frac{e_s}{1 - e_p}$$

$$\text{where } e = \frac{m_p - f}{m_p\,(1 - f)}$$

(iii) Calculate R_v by the formula

$$R_v = \frac{1}{1 + \left\{\frac{1}{R'_v} - 1\right\}\frac{Kmp - 2mp + 1}{Kmp}}$$

(iv) From R_v and n, the No. of mill in the imbibition train; find out the ideal value of K_i as per theory, by referring to Table I of Noel Deerr's paper (*I.S.J.*, 1930, 473).

(v) Efficiency of the secondary unit

$$= \frac{K_i}{K} \times 100.$$

Symbols: J = Juice per unit cane.
g — Brix.
f = fibre per unit cane.
m = fibre per unit bagasse.
e = extraction.
K = added water per unit fibre.

Suffixes: s = secondary, p = primary, m = mixed.

197. A Comparative Study of the Properties of Synthetic fibres prepared by Viscose Process from different Cellulosic Materials.

P. S. VARMA *and* ABHAYA SINHA (Benares)

Synthetic fibres from different cellulosic materials have been prepared and their physical and chemical properties have been examined. Only a slight variation in properties was noticed.

198. Cost of Production of Synthetic Fibres in India.

P. S. VARMA *and* ABHAYA SINHA (Benares)

Artificial silk has been prepared on the model Hagihara machine in the Industrial Chemistry Laboratories of Benares Hindu University by the viscose process from cellulose obtained from various cellulosic raw materials such as jute, hemp, flax, filter-paper cuttings, bamboo-pulp, waste cotton, and waste materials of cotton mills. The cost of cellulosic raw materials varies from one anna and nine pies to five annas and six pies per lb., and the cost of production of artificial silk on the basis of work carried on in our Laboratories comes up to about one rupee and eleven annas per lb., if the production is started on the minimum economic scale.

199. The Anodic Oxidation and Colouring of Aluminium and Aluminium Alloy Articles.

D. R. DHINGRA, G. N. GUPTA *and* M. G. GUPTA (Kanpur)

The paper gives in detail the theory and processes of anodic-oxidation and colouring of aluminium and aluminium alloys. It is well known that owing to the great affinity of aluminium for oxygen, an oxide film is readily formed when it comes in contact with an oxidising solution. The greater the thickness of the oxide coating, the greater is the protection from atmospheric conditions and corrosion, etc. There are two processes of oxidation: (1) Chemical and (2) Electric-chemical.

In the chemical process, aluminium is immersed in an oxidising solution, *e.g.*, Potassium dichromate or a mixture of sodium carbonate and sodium chromate for 5 to 20 minutes, whereby an oxide coating is deposited on the surface. The oxide coating in such cases is very thin.

To make the coating thicker and uniform, an electro-chemical process is used wherein the metal undergoes anodic oxidation.

Electrolytes, *viz.*, chromic-acid, sulphuric acid, sulphuric acid in combination with glycerine, oxalic acid, ortho-phosphoric acid, boric acid, sulphamic acid, etc., of different concentrations have been studied for satisfactory anodic films on aluminium and aluminium alloys from aeroplane scrap. The optimum working conditions with regard to temperature, voltage, current density, etc., have been found out. It has been shown that sulphuric acid for aluminium and chromic acid for aluminium alloys are most suitable.

For colouring of oxidised aluminium a number of dyes available in the market were tried and very beautiful shades were obtained on aluminium and aluminium alloys. Inorganic colours were also employed.

Details of equipment necessary for utilising 1 cwt. of aluminium sheet per day are given. It is shown that a net profit of 35% on the investment can be expected in the factory.

200. Possibility of Manufacture of Caustic Soda from naturally occurring Reh Soil.

D. R. DHINGRA *and* S. N. GHATAK (Kanpur)

Reh soil or Rehu matti is a naturally occurring alkaline soil found in the Indo-Gangetic plain. Reh soil mostly contains the soluble salts of sodium (carbonate, sulphate and chloride) clay and organic matter. Reh soils varry in composition from place to place. Sodium carbonate content varies from 1 to 9% sodium sulphate 1 to 6% and sodium chloride 1 to 3%. The important constituent of Reh soil is sodium carbonate. In the villages where the Reh soil is available it is leached with water and the extract evaporated to dryness. This crude product is technically called Sajji which contains 35 to 55% sodium carbonate, 15 to 30% sodium sulphate and 5 to 10% sodium chloride.

For the preparation of crude caustic soda sajji was roasted to free it from organic colouring matter. It was then extracted with boiling water. The extract was decanted and filtered off from insoluble matter and causticised with the required amount of lime (theoretical quantity *plus* 20% more). Causticised liquor was concentrated to 70° TW (1·35 sp.gr.) when sodium sulphate crystallised out. The solution was then concentrated to above 50° Be (1·526 sp.gr.) or evaporated to dryness to yield lumps of caustic soda. Incrustation formed, from time to time, was separated by means of perforated laddles and flakes were obtained. The following results were obtained:—

Sajji containing 32% Na_2CO_3 gave a yield of 87·5% caustic soda (solid lumps) and 75% caustic soda (flakes). Solid caustic soda composition was 79·08% NaOH, 7·50% Na_2CO_3, 3·05% Na_2SO_4 and 1·07% NaCl. Flakes had 92·8% NaOH, 0·8% Na_2SO_4 and 0·3% NaCl.

In these days of acute shortage of caustic soda causticisation of crude sajji is a very paying proposition.

201. Treatment of Effluents of Distilleries and Tanneries.

D. R. DHINGRA *and* S. N. GHATAK (Kanpur)

The following experiments were conducted for the treatment of the foul smelling effluents from distilleries and tanneries:—

1. *Distillery effluents.*—Cultured yeast was added (10 grams to a gallon) to the effluent. Air was blown in for about 72 hours to enhance the fermentation. Occasionally steam was passed in order to maintain the temperature at 40° C. (Hot air can also serve the purpose). The acidity was determined and the required amount of lime (12 to 15° Be) was added to bring the pH to about 7. Air was blown for 12 hours and the solid matter allowed to settle. The decanted liquor was taken in another container. " Alumina-Ferric " was added to the liquor at the rate of 1 oz. to a gallon and air was again blown in for another 12 hours. Kept overnight the liquid was perfectly free from smell or suspended impurities. The separated solid may be used as a manure. The liquid, after treatment with bleaching powder (0·25 oz. to a gallon), can be used for irrigating the fields or can be allowed to run into the river without producing any harmful results.

2. *Tannery effluents.*—This type of obnoxious effluent contains suspended matter: hide pieces, skin and hair. Air was blown in for 12 hours and the liquid allowed to settle. Decanted liquid was treated with Alumina-Ferric (4 oz. per gallon) and air was blown in for another 12 hours. The liquid was then passed through a bed of kankar, coal cinder and sand, arranged in 3 layers. The liquid after passing through the filtering bed was treated with bleaching powder (0·25 oz. per gallon). The treated effluent was free from smell or suspended impurities. The solid residue had 2·6 to 3% nitrogen and could be used as a manure. The treated effluent could be used for irrigation of fields.

1290-47 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent.

SECTION OF MATHEMATICS

PRESIDENT : R. VAIDYANATHASWAMY, Ph.D., D.Sc.

1. On a recurrent.

S. CHAKRABARTI, Jadavpur.

If

$$D_3 = \begin{vmatrix} {}^6S_1 & {}^6S_2 & {}^6S_1 & {}^1S_2 & a^2 + (-)^3\, {}^6S_1 \\ 1 & {}^5S_1 & {}^5S_1 & {}^3S_2 & a^2 \\ & 1 & {}^4S_1 & {}^2S_2 & a^2 \end{vmatrix}$$

then $D_K = (-)^p\, {}^{k+3}S_1 \begin{bmatrix} k+2 \\ 3 \end{bmatrix}_2$ or $(-)^p\, {}^{k+3}S_1 \begin{bmatrix} k+1 \\ 1 \end{bmatrix}_2 a_{k+1}$ according as k is odd or even,

p being the integral part of $\frac{k-1}{2}$ and $a_{k+1} = 1 + a^3 + a^5 + \ldots + a^{k+1}$.

2. Bending of clamped rectilinear plates.

B. R. SETH, Delhi.

In a recent paper we have discussed the bending of rectilinear plates with supported edges and have shown how the solution can be made to depend on the corresponding solution for the boundary when the plate is bent by uniform pressure. When the edges are clamped, the problem does not yield an easy solution. The known case of a rectilinear plate has been widely discussed , and its solution has been obtained in the form of a double Fourier's series. In this paper it is shown that the general case of a rectilinear plate can also be obtained in the form of a double Fourier's series. The case of a regular polygonal plate is discussed in detail.

3. A type of solutions of Einstein's gravitational equations.

J. GHOSH, Chinsura (Hoogly)

Assuming the gravitational equations in the form

$$k_{pq} - \tfrac{1}{2} g_{pq} k + \beta g_{pq} = -8\pi\ T_{pq}$$

the author has derived a complete solution of the problem of a homogeneous material sphere in which the radial and transverse stresses are linearly related.

4. On linear difference equations.

S. M. SHAH, Aligarh.

In a recent paper (Bulletin American Math. Soc. Vol. 53 No. 6, June 1947 pp. 548-558) I proved that if $y(x)$ be a real continuous solution of an algebraic difference equation of the first order,

$$P(y(x+1),\ y(x),\ x) = 0 \qquad \ldots (1)$$

then

$$\lim_{x \to \infty} \inf \frac{\log \log |y(x)|}{x} < \infty$$

I also showed that this result is the best possible. If however we consider linear difference equation with polynomial coefficients

$$P_m(x) y(x+m) + \ldots + P_0(x) y(x) = Q(x) \qquad \ldots (2)$$

then we can obtain a better upper bound for $y(x)$.

Theorem

If $y(x)$ be a real continuous monotonic solution of linear difference equation (2), *then*

$$\lim_{x \to \infty} \sup \frac{\log |y(x)|}{x \log x} < \infty$$

Two more theorems on linear difference equations are also established.

5. Note on a new method of solving problems of thin elastic plates.

B. Sen, Sibpur.

Recently a new method of finding stresses in large thin plates has been discussed in a paper accepted for publication elsewhere (Sen, 1946). In this note the method has been extended to problems of thin plates having cavities of different shapes, the plates being supposed to have a distribution of all round tension at great distances from the cavities. The cavities considered are those having boundaries in the form of (1) an inverse of an ellipse, (2) a loop of a lemniscate, and (3) an approximate square with rounded corners.

6. Vibrations of an infinite linear lattice consisting of two types of particles.

N. S. Nagendra Nath *and* Sanat Kumar Roy, Patna.

The problem of the vibrations of a linear lattice has attracted considerable attention from the time of Lagrange who investigated the vibrations of a finite lattice with fixed end particles (*Mecanique Analytique* Vol. 1.). Hamilton investigated the problem of the vibrations of an infinite linear lattice consisting of identical particles under certain initial conditions(*Hamilton's Mathematical Papers* Vol. 2.). This paper deals with the vibrations of an infinite linear lattice consisting of two types of particles. The solutions for the displacements can be represented as complex integrals taken along suitable contours on a Riemann Surface of four sheets. These solutions are

$$x_{2r} = \frac{1}{2\pi i} \int \frac{f_1 \cos \omega_1 t + f_2 \cos \omega_2 t}{z^{r+1}} \, dz$$

$$x_{2r+1} = \frac{1}{2\pi i} \int \frac{g_1 \cos \omega_1 t + g_2 \cos \omega_2 t}{z^{r+1}} \, dz$$

where f_1, f_2, g_1, g_2, ω_1 and ω_2 are certain functions of the complex variable z. When the masses are equal the solutions reduce to Bessel's functions of even order (Hamilton's Solution). The asymptotic nature of the above integrals has been investigated by the method of steepest descents. This shows that any general solution is tobe obtained as a Fourier wave packet and that it tends to a superposition of limiting vibrations as t tends to infinity.

7. On cases of extremum of an interpolation polynomial in two variables.

Anunoy Chatterjee, Patna.

When a set of three observations are taken near a maximum or a minimum, the approximate value of the independent variable for which the interpolation polynomial is maximum or minimum has been obtained (Milne-Thomson, Finite Differences, 1933, 19). In the present paper the author has investigated the cases of extremum of the interpolation polynomial for four observational values at the corner points of a small rectangle in near vicinity in the XY-plane and has attempted to deduce sets of sufficient conditions that such an extremum may be a real maximum or a real minimum with regard to the four observational values.

8. The asymptotic number of latin rectangles.

S. M. KERAWALA, Calcutta.

Recently, Erdos and Kaplansky have succeeded in proving that the number $f(n,k)$ of n by k Latin rectangles is given asymptotically by :

$$(n\,!)^k \exp\,(-kC_2)\left[1-\frac{k(k-1)(k-2)}{6n}+\frac{k(k-1)(k-2)(k^3-3k^2+8k-30)}{72n^2}+C\right]$$

where $C=0(n^{-3})$. In this paper, I show that

$$C=\frac{k(k-1)(k-2)(5k^6-30k^5+155k^4-780k^3+1874k^2-4788k+9288)}{6480\,n^3}+0(n^{-4})$$

9. A note on the equilibrium of a fluid-mass under a steady differential rotation.

N. L. GHOSH, Calcutta.

The purpose of the present paper is to point out certain restrictions on the density-distribution of a fluid-mass rotating steadily about an axis of symmetry with a variable angular velocity, in the case where the gravitational potential is a function of the density only. Such a case has been considered by P. Dive in Rotations Internes Des Astros Fluides, though no solutions have been obtained and the restrictions inosed on the density by the assumption have not been noticed either.

The note also contains two illustrations of the general problem mentioned under the assumption that the potential is due entirely to a very heavy central attracting sphere. It has been found that it is possible for the surrounding fluid to be in equilibrium either in the form of a spheroid, very much like a thin atmosphere or in the form of an anchor ring with the attracting mass at the centre. No pressure density relation has been assumed. The question of stability, however, has not been investigated.

10. An inversion formula for the generalised Laplace transform.

R. S. VARMA, Lucknow.

In a paper to be published in the Proceedings of the Edinburgh Mathematical Society, I gave an inversion formula for the generalised Laplace Transform, given by me at the Indian Science Congress, Nagpur (1945). In this paper, I have investigated another inversion formula for this transform.

11. On a fluid motion possessing axial symmetry.

RAM BALLABH, Lucknow.

A study has been made of rotational motions (velocity q) in a homogeneous incompressible viscous fluid, for which

$$r.\,\nabla\times q=0$$

and which can be superimposed upon the irrotational motion given by

$$\varphi=Ux,$$

U being a constant.

It has been shown that

$$u=u_0+\tfrac{1}{2}\int f(Y)\,dY$$
$$v=v_0$$
$$w=w_0$$

u_0, v_0, w_0 being harmonic functions, and $Y=y^2+z^2$

Particular solutions making the fluid velocity vanish at infinity have also been obtained.

12. A generalisation of the Hankel-Transform.

R. P. AGARWAL, Lucknow.

In this paper I have generalised the Hankel integral equation

$$g(x) = \int_0^\infty (xy)^{\frac{1}{2}} \, J_\lambda(xy)\, f(y)\, dy$$

by considering the kernel $(\frac{1}{2})^\lambda x^{\lambda+\frac{1}{2}} J^\mu_\lambda(x^2/4)$ where

$J^\mu_\lambda(x)$ is the Maitland's Generalised Bessel functoin. I have also deduced a number of properties of functions connected by the integral equation

$$g(x) = (\tfrac{1}{2})^\lambda \int_0^\infty (xy)^{\lambda+\frac{1}{2}} J^\mu_\lambda\left(\frac{x^2y^2}{4}\right) f(y)\,dy$$

This equation for $\mu = -1$ reduces to the ordinary Hankel's Equation.

13. On the non-summability (A) of the conjugate series of a Fourier series.

U. N. SINGH, Allahabad.

In this paper we prove the following theorem.

Theorem. At a point x, where

$$\int_0^t \psi(u)\,du = O(t), \quad \psi(u) = f(x+u) - f(x-u).$$

the divergence of the integral $f_\eta(x) = \dfrac{1}{2\pi}\displaystyle\int_\eta^\pi \psi(t)\, \tfrac{1}{2}\cot \tfrac{1}{2}t\,dt$ *as* $\eta \to 0$, *to* $\pm\infty$ *is a necessary and sufficient condition for the divergence to* $\pm\infty$ *of the conjugate series of the Fourier series of* $f(x)$.

14. On the Nörlund summability of Fourier series.

J. A. SIDDIQI, Allahabad.

A sequence (s_ν) is said to be summable by a regular generalized Norlund method of summation (N, p_ν) if

$$\lim P_n^{-1}(p_n s_0 + p_{n-1} s_1 + \ldots + p_0 s_n)$$

exists, where $P_n = p_0 + p_1 + \ldots + p_n \neq 0$, (p_ν), being a sequence of complex numbers subject to the regularity conditions

$$\sum_{k=0}^{n} |p_k| < b\,|P_n| \qquad \lim_{n\to\infty} \frac{p_n}{P_n} = 0$$

We have established the following theorem :

Theorem : A regular Norlund method of summation (N, p_ν) sums the Fourier series of a function $f(x)$ which is integrable in the sense of Lebesgue and is periodic with period 2π, to the sum $f(x)$ at the points at which

$$\int_0^t g(u)\,du = O(t), \qquad \int_0^t |g(u)|\,du = O(t)$$

provided the generating sequence (p_ν) satisfies the following condition

$$\sum_{k=0}^{n} |\Delta p_k| + |p_n| < b\,|P_n| \cdot n^{-1}$$

SECTION OF ANTHROPOLOGY AND ARCHAEOLOGY

PRESIDENT : A. CHATTERJEE, M.B., B.S.

1. Study of the head-hair of the Parois, a fishing Caste of Hogladanga in the district of Jessore, Bengal.

M. N. BASU, Calcutta.

Sixty hair samples are studied with respect to -

(1) Colour --Matching with the graded tones of the Fischer-Saller Haarfarbentafel.
(2) Form --Microscopic examination after Trotter, to find out the index.
(3) Size—Area of cross-section.

2. Book insects and Preservation.

M. N. BASU, Calcutta.

Different kinds of book insects, their habitat and the methods of preservation are discussed.

3. Study of the voluntary movements recorded by Dynomometer as modified by pleasant and unpleasant stimuli among the Noluas of Bengal.

M. N. BASU, Calcutta.

Experiments on 200 adult male Noluas, age varying from 22-30 years, are done. Effects of pleasant and unpleasant stimuli are also discussed.

4. A note on a dipnet- the Vesal.

M. N. BASU, Calcutta.

The specimen is collected from a fisherman's village (Hogladanga) in the district of Jessore, Bengal. An ethnographical account is stated.

5. A preliminary note on comparability of measurements.

K. P CHATTOPADHYAY, Calcutta.

In determining racial affinity, it is often necessary to compare measurement of living subjects, taken by different observers. As the landmarks on a living subject are not so exactly defined as on crania or the limb bones, it is important to ascertain how far measurements on the living are comparable, when made by different observers. In the series of observations described head length, head breadth and head height on the same set of 50 subjects by three observers. The results are analysed.

6. The Korku village and house type in Melghat.

K. P. CHATTOPADHYAY, Calcutta.

In this note the writer describes the plan of Korku villages in Melghat forest, and and the details of construction of the huts.

7. A Santal scissors trap.

K. P. CHATTOPADHYAY, Calcutta

The writer describes a somewhat uncommon type of trap collected by him among Santals. It has been found by Hutton among Nagas of Assam.

8. Santal economy in Bengal.

K. P. Chattopadhyay, Calcutta.

The writer describes the present structure of landownership among Santals in Bengal and compares it to their traditional concept of rights in land.

9. Megalithic Monuments of the Chingleput District.

V. D. Krishnaswami *and* N. R. Banerjee, Madras.

This paper incorporates an account of the recent exploration conducted by the Archaeological Survey of India, in the Chingleput District, adjoining Madras, and in the areas peripheral to it.

The previous casual notices of megalithic sites in this region, served along with other geomorphic factors to make a thorough ground survey for these monuments, long wished for by Robert Sewell, since 1882.

Physiographically the region is divisible into two parts, lateritic in the North and granitic in the South. While the control of Geology can always be traced on the monuments, the megaliths, here, resolve themselves into two main types: namely (a) Cairn circle, and (b) Dolmenoid Cist. They have also a number of variations and there are also barrows (urnfields). The mutual relationships between them are discussed in detail.

A study of the associated pottery and other objects collected from these megaliths has been dealt with at some length, with a view to dating these eluding monuments of Chingleput, that relate to a robust civilization, long forgotten, but very near to our own, in social structure. The distribution of these monuments in Chingleput indisputably leads to the conclusion that the megalithic folk have heralded the introduction of the irrigation complex into this part of India.

10. A study of the Surnames of the Daksinatya Vaidika Brahmans of Bengal.

T. C. Ray Chaudhuri, Calcutta.

The Kulapanjikas give a number of surnames of the Daksinatya Vaidika Brahmans of Bengal. Most of them have become obsolete of these some may still be traced in local names. Some again such as Dhar Sharma, Kar Sharma, Nandi Sharma and Bhadra Sharma may throw some light on their social relations. These surnames without the appendix sharma are found among the Vaisyas, Kayasthas (Sudras) and Vaidikas. Manu's injunctions regarding surnames. At present the surnames, Dhar, Kar, Nandi, Bhadra, Sen, Shur, Deva, Bhrahma, Chandra, Shome, Dutta, Aditya, Mitra etc--are met with in the Kayastha (sudra) society. Now that being so are we to correlate the D. Vaidikas with the Vaisyas or Kayasthas? Of these Kayasthas cannot claim to have a separate existence as a caste group --they are not heard of before the 9th Century.

11. Traditions regarding the early history and migration of the Vaidika Brahmans.

T. C. Ray Chaudhuri, Calcutta.

Kulakarikas are at variance Tradition regarding origin--regarding Jasodhara--Syamal Varma Relative priority of the two Sections--Pascatya and Daksinatya--The filiation of the Vaidika Brahmanas cannot be supported by anthropometric data.

12. Blood Groups of the Oraons working in the Tea Estates of Duars in Jalpaiguri District.

R. N. Basu, Calcutta.

13. Bengali Mandible—its Osteometric measurements.

R. N. Basu, Calcutta.

50 mandibles were measured and their data analysed.

14. Investigation of the foramen Crotophitico Buccinatorius in the Human Skull.

M. M. Cooper, Medical College, Madras.

The aim of this paper is to investigate the occurrence of the foramen Crotophitico Buccinatorius in the human skull. This foramen is a constant feature in the monkey.

The earliest reference to it was made by Hyrtl in 1862. Bryce in Quain's Anatomy describes the foramen in about 1.4% of human skulls.

It is stated that this foramen is precisely betwween the lateral pterygoid lamina and the under surface of the great wing of the sphenoid, transmitting when present "the lesser division of the mandibular nerve".

OBSERVATIONS :

A hundred South Indian skulls in the Department of Anatomy (Madras Medical College) were examined, and in one skull the foramen was found well formed and that only on one side. On the other side it was present but incomplete. The foramen was seen to be formed by a bar of bone extending from the root of the lateral pterygoid lamina to the under surface of the great wing of the sphenoid. Three other skulls, showed the foramen, ill-formed, represented only by two opposing spicules of bone.

DISAPPEARANCE OF THE FORAMEN IN MEN :

The cause of disappearance from the human skull, of this foramen, ordinarily found in the monkey, remains unexplained. An attempt is made here to offer a probable explanation.

In the monkey the lateral pterygoid lamina is (in proportion to skull dimensions) very much broader, than in man, and has consequently greater access to the under surface of the greater wing of the sphenoid, reaching which, it encloses the foramen crotophitico buccinatorius. In man however, the lamina has narrowed down, with the consequent obliteration of the foramen. The reason as to why the lamina has narrowed down is to be found in the fact that man's masticatory powers and function have been much reduced; and the lamina which gives rise to a powerful muscle of mastication has consequently become narrow. This is in keeping with Weidenreich's view.

15. Notes on land tenure and law of inheritance among the aboriginal people of Assam.

Tarakchandra Das, Calcutta.

Conception about ownership of land among the shifting hill cultivators. Consideration of the claims of different bodies to the land around the village. Recent changes in attitude. Suggestions for enactment.

Inheritance of movable and immovable property among the Assam tribes. Distribution of primogeniture and ultimogeniture in Assam. Recent trends of changes in the law of inheritance.

16. Acculturation in a tribe of Chota Nagpur

By Tarakchandra Das, Calcutta.

The Hos of Kolhan have come in contact with the advanced people of Chota Nagpur and its surrounding regions for a long time. The process of acculturation started by this contact has received new impetus through industrialization of the district of Singbhum and improvement of transport facilities.

Changes introduced in different culture-traits. Consideration of their effect on the life of the Hos.

17. The aboriginal problem in India.

L. A. Krishna Iyer, Madras.

Tribal administration has been a Central subject under the Government of India Act of 1935. The Government of India classified aboriginal areas into Excluded and Partially Excluded Areas which kept them beyond the purview and jurisdiction of the Provincial Governments. With the grant of freedom to the Indian Union, Provincial Governments will have to assume responsibility for the care and welfare of the aboriginals in their areas. Already the Mardas, Bombay and United Provinces Governments

have constituted Aboriginal Committees to report on measures for their uplift. Anthropologists should be associated with tribal work to preserve tribal culture. The Government of H. E. The Nizam of Hyderabad have established a Social Service Cadre under Baron von Furer Haimendorf to administer the aboriginals. Orissa also has created a Social Welfare Department. It is hoped other Provincial Governments will follow in their wake and enlist the services of anthropologists for their work.

18. Blood group frequencies in the various castes and tribes of cultural Gujerat.

D. N. Majumdar *and* K. Kishen, Lucknow.

About four thousand people of Gujerat including Kathiwar and Kutch were examined in connection with the Racial and Serological Survey of Cultural Gujerat on a random sample basis, in 1946. The Survey was undertaken at the invitation of the Gujerat Research Society, Bombay, and financed by the Society.

In this paper, the results of the statistical analysis of the blood-groups data of 22 castes and tribes of cultural Gujerat are presented. The analysis reveals heterogeneity among the estimated probabilities of A, B, and O genes for the 22 castes and tribes which is ascribable to the differences among the estimated probabilities p of A genes, q of B genes and r of O genes. Whilst the results are in conformity with those derived from the analysis of the anthropometric data they are in contrast with those obtained from the analysis of blood groups data of respresentative castes and tribes of the United Provinces where the heterogeneity among the estimated gene probabilities was attributable only to the differences in p, the differences in q and r being not significant. (The Eastern Anthropologist, Vol. I, No. I, pp. 8-16)

19. Industrial relationship in some industries of Bengal.

J. K. Bose, Calcutta.

Very few attempts have been made to study industrial relationship from the scientific point of view. In this paper an attempt has been made to show the relationship between the worker and management in some industries around Calcutta. Some of the typical cases have been discussed to illustrate the present position and a suggestion has been made for its improvement.

20. On the Finger and palmar prints of the Santals.

P. C. Biswas, Delhi.

The present paper is on the finger and palmar print of the Santals of the Maldah District of Bengal. In the Santal hand the white formula 11.9.7.(1-5) appears in larger number than the Negro formula, 7.5.5.(1-5). The pattern loop appears on the hypothenar area of the Santal hand, in 28%, and on thenar area only, in 6% and on the III and IV interdigital areas it appears in 18% and 34% respectively. Among the combination formulae of the three interdigital areas of the hand of the Santals, 0.S.0., 0.0.S., and 0.0.0. appear in higher frequency.

The pattern loop, in the fingers of the Santal, appears in larger number than the whorl and in the occurrence of patterns loop and whorl in the finger of the Santal, a great similarity can be seen with the Negroes.

21. An Epigraphical record of a social ostracism

R. Basudeva Poduval, Trivandrum.

22. A note on Rh. incidence.

S. D. S. Greval, Calcutta.

SECTION OF MEDICAL & VETERINARY SCIENCES.

PRESIDENT: DR. G. D. BHALERAO, Ph.D. (Fac. Med. London), D.Sc. (London & Allahabad) F.Z.S., F.R.M.S., F.A.Sc.

MEDICINE AND PUBLIC HEALTH

1. A study of Lichen Planus in India.

G. PANJA, Calcutta.

The ætiology of the disease was investigated. No micro-organisms were found in the lesions by ærobic and anærobic cultures. The virus theory was also investigated. No solid immunity, no agglutinin against the filtrate of suspension from materials in the lesions, no inclusion bodies in the lesions and no marked improvement with the so-called virus vaccines prepared from the lesions were noticed. The disease was found non-contagious. It showed a plexus or spinal outflow distribution, the lower outflow being more often and more markedly affected than the upper one. The histological picture suggests that the disease primarily occurs in the dermis. The affection occurs morecommonly amongst better classes of people. Clinical features of the disease were studied.

Sodium thiosulphate one gm. intravenously twice or thrice a week should be given in acute cases. Autogenous vaccine from stool cultures and arsenic in the form of soamin or enesol are found good in subacute and chronic cases. X'ray exposures to the lesions are found invaluable. An effective external treatment is suggested.

2. Staphylococcal Summer Gastroenteritis at Lucknow.

A. MUKHERJI, Lucknow.

Towards the end of March Gastroenteritis occurs every year at Lucknow and continues for about six months. There is vomiting and purging, but the vomit is neither watery nor is the stool like rice water. The pulse rate bears a proportion to the temperature. Stools are as a rule negative for *Vibrio choleræ*. A preliminary investigation in 1945 pointed towards the possibility of staphylococci being the causative organisms.

This year (1946) 134 stools of gastroenteritis and suspected gastroenteritis were examined bacteriologically. Nine stools revealed *Shigella*, fifteen vibrios and eighty-one showed only staphylococci, twelve of which were strictly anærobic, 29 had no pathogenic organisms. Various tests were carried out with 69 strains of ærobic staphylococci, 44 of which were of aureus type, 18 albus type, and another 4 of citreus type.

Out of the 69 ærobic strains of the staphylococci coagulase test for virulence were carried with 31 strains and all were found to be positive. Enterotoxin tests were carried out with toxins prepared from eleven of the strains grown in Huntoon's Hormone broth for five days at 37°, when four to five c.c. of these toxins were injected intraperitoneally to healthy adult cats. They had tremors, rise of temperature to about 40° C, vomiting and purging. This proves that the strains of staphylococci isolated from the stools of gastroenteritis patients cause the disease.

3. Melioidosis in a Sepoy.

P. R. KRISHNA IYER, Izatnagar.

Blood and urinal samples from Sepoy Aji Ram, age 25 years, an inpatient in 135 I. B. G. H. Bareilly were received for examination. The patient was suffering from pyrexia of an undulant type for about 6 months and he was suspected for *Brucella melitensis* infection. Biological and cultural tests, however, revealed Melioidosis, *Pfeifferella whitmori* being isolated in pure culture from the lesions in the testicles, lungs, liver, and spleen of the inoculated guinea-pig The patient had a history of field service in Burma and far eastern colonies.

4. Biometric Studies of School Children of Hyderabad State.

M. B. DAVER, Hyderabad-Deccan.

It is the first biometric study of school children of Hyderabad State. An investigation of the state of nutrition of over 18,000 school children has been done. Average height and weight for the age group 6 to 15 (boys) was determined. The averages are compared graphically with those of Punjab, Bengal, Madras, Ceylon and American and British boys. Indian children of a given height weigh much less than British or American children. School boys from Punjab and Bengal are heavier and taller than those from Hyderabad State; but Hyderabad boys are superior both in height and weight to Madras and Ceylon school boys. The general result of our investigation is to show that a large percentage of school children in groups examined are suffering from malnutrition due to deficiency diet, both in quality and quantity.

5. Food and its Adulterants.

S. K. CHATTERJI, Calcutta.

Much stress has been laid on the adequate supply of wholesome food to the mass. This country, being a land of plenty can supply that. Proper cultivation, strict supervision and adequate distribution are the three essential factors which come in forefront in the problem. A wholesome food should supply proteins, fats and carbohydrate with vitamins in such a proportion that 3000 calories must be had for an individual as his daily requirements. Lack of these factors in the foodstuff would invariably produce various deficiency diseases and thus would cripple up the whole nation.

Milk being the essential food for growing children, invalids and old are seldom obtained in a pure form. Addition of water to whole milk or to separated milk, adulteration of cow's milk and buffaloe milk with each other, a mixture of fresh milk with stale milk or a mixture of milk powder to diluted milk are the usual procedure for adulterating the milk in this country.

Mustard oil has been known to be adulterated with Pakra oil, argemone oil, arachis oil or even with mineral oils. Recently six samples of mustard oil were forwarded to this department to determine if they were fit for human consumption. They were all found to be heavily adulterated with mineral oil. Cocoanut oil has also been known to be adulterated with cheap groundnut oil.

Ghee is seldom available in pure form. It is invariably adulterated with hydrogenated oil or cheap animal fat. A case of adulteration of ghee with petroleum jelly is also known to have occured.

Milk, oil or ghee can however be tested for purity according to the standards laid in the Food Adulteration Act.

Rice and wheat the two staple diets of the nation are also sold in an adulterated state in the market. On being stored for a long time in a damp unhealthy place the quality of rice and wheat deteriorates, looses their Vitamin B, and mineral contents and become unfit for human consumption. Estimation of the Vitamin B, and mineral contents are essentially necessary in these foodstuff in addition to the physical characters to determine their suitability for human consumption. A sample of atap rice should contain Vitamin B,-1 mg|mg and ash .5%. (minimum value) and a sample of unpolished rice should contain vit B, 1.5 Mg.|gm. and ash. 7% (minimum).

The wheat and wheat products are heavily aduterated with all possible adulterants. An admixture of bajra, rice or maize starch or of powdered silicates or stone chips with wheat product (atta) had been in practice for sometime. The adulteration with powdered seed of ripe tamarind fruit is a recent development. Soap stone or alum are also possible adulterants In some cases no wheat starch is present at all in the so called wheat product (atta) sold to public, which consisted entirely of foreign starch or even in some cases no starch at all.

Powdered stone chips, soap stone or alum have no food value rather act as irritants. The foreign starch grains of bajra, rice or maize though not harmful are not desirable. The seeds of ripe tamarind fruit, which contain a small quantity of starch (in addition to certain amount of protein and fat) is said to possess an astringent property and used in cases of dysentery with good results. Thus these tamarind seeds powder can not either be said to be harmful though not desirable.

The Food adulteration Act lays stress on the value of the percentage of ash in these wheat products as the criteria for purity. But the presence of gluten as a qualitative test should also be looked for as routine method to identify the wheat product (atta) and the percentage of gluten should also be determined on which the purity of the staff depends to a certain extent.

6. Calcium Hydroxide (Lime) as a posion.

S. K. Chatterji *and* H. D. Ganguli, Calcutta.

Death from poisoning by a caustic alkali is a rare incident, though of course cases of death from poisoning by caustic soda or caustic potash are on record. But an incident like poisoning by calcium hydrocide (lime) is not on record at all. Such a rare case is therefore no doubt of medicolegal interest.

Portions of human viscera of an undertrial prisoner in a jail was forwarded to us for chemical analysis with a history that the victim committed suicide by taking some lime. He had several vomiting and died in about 2½ hours of taking the lime, the exact amount of lime taken was not known. On post mortem examination the internal organs were found to be only slightly congested. On chemical analysis salts of calcium amounting to 1.34 gram estimated as calcium oxide was detected in the total quantity of the liquid contents (about 200 c. c.) found inside the jar containing the viscera. Calcium oxide (unslaked lime) or calcium hydroxide (slaked lime) are used externally as a caustic in the form of a paste (Vienna paste) to remove warts and other epithelial growths. Calcium hydroxide (lime) is also taken by mouth with betels in pan but that is in a very small quantity, which produces only beneficial effect but no harm.

When taken by mouth these oxides and hydroxides may act as a corrosive poison, the intensity varying with the amount taken. The action of the oxide or hydroxide is due to the alkalinity and not due to calcium. The symptoms of poisoning being as usual severe burning pain in the mouth extending up to the stomach. Vomiting may also take place, the vomited matter having an alkaline reaction. There may be shock and collapse with rapid feeble pulse, cold clammy skin and death may follow within 24 hours as in other strong alkali poison,

These corrosive alkalies are usually used for suicidal purposes rather than homicidal. The treatment followed may be the usual procedure as in other corrosive alkalies

7. A Case of rapid elimination of Arsenic from tissues in a fatal case of poisoning.

S. K. CHATTERJI *and* H. D. GANGULI, Calcutta.

Arsenic is a commonly used poison employed for homicidal purpose and the detection of arsenic in the cadaver in a fatal case is of great interest from medicolegal point of view.

Arsenic on being absorbed from the intestinal canal passes to the liver and quite a fair amount is stored there. From liver it passes through blood stream to different parts of body and is then gradually excreted by the kidneys. It has been found that after a single dose of arsenic, it gets eliminated in the urine within half an hour and continues to be excreted for about 10-15 days. In acute arsenical poisoning cases the excretion takes place through urine even for a longer period.

The distribution of arsenic in different parts of body depends much upon the interval between the intake of the fatal dose and the death of the individual. In rapidly fatal cases, the stomach and its contents usually show the presence of relatively larger amounts of arsenic than the other organs, as much time is not elapsed for the poison to be absorbed. In cases where vomiting has been excessive, a large portion of the ingested arsenic is lost by this procedure and very little is left for detection. Though of course there are cases reported in which considerable arsenic has remained in the stomach even inspite of constant vomiting for several days It is also certain that there will be more arsenic found in the stomach if the poisen be taken in solid form than if it is ingested in solution, as the former has a tendency to fix itself to the mucosa and is not ejected out with vomitus.

Arsenic is usually found in tissues submitted for examination in cases where death has not been delayed, yet there are cases on record in English Text Books of Jurisprudence in which no arsenic has been found in any such tissues where death, took place after a period of 7-14 days.

Severi failed to detect arsenic in the stomach and intestines, liver, spleen and kidneys of a person who had died in 8 days after poisoning by Arsenic. In a case of death from arsenical poisoning who suffered the usual symptoms and died on the 16th day, though the stomach was found to be ulcerated, no arsenic was detected on analysis of stomach, liver and spleen.

Elimination aided by copius vomiting caused the removal of all detectable quantities of arsenic in the case of a man who died in 11 days after having been poisoned by arsenic in coffee. No arsenic was detected in the stomach, liver or spleen on analysis.

Recently one such case happened in this country in which the victim was said to have been poisoned by the rival party with the effect that the said victim had severe vomiting for 2 days and then died of exhaustion. On postmortem examination the internal organs did not reveal any definite sign of poisoning and no poison could be detected in the stomach, liver and kidneys of the deceased forwarded for examination in this department. A quantity of earth said to be mixed with the vomited matter of the deceased was forwarded to us later in which an appreciable amount of arsenic was detected. On estimation 3.4 mgs of arsenic (calculated as As_2O_3) was detected in 5 grammes of earth.

A sample of earth from the neighbourhood was wanted for control test and it was found to be arsenic free. So the incessent vomiting for 2 days has eliminated the whole amount of poison administered. This I presume would be of medicolegal interest

in which no arsenic could be detected in the tissues in a case in which death took place only after 2 days of intake of the toxic dose where elimination aided by copious vomiting caused the removal of all detectable quantities of arsenic.

8. "Kirkku Varaghu" Poisoning in man and Animals in Madras Presidency.

G. R. VISWANATHAN, Madras.

Paspalum scrobiculatum, otherwise called in Tamil as Varaghu, is generally used by the middle and labouring class of this presidency as food, instead of rice. This is supposed to be one of the best food containing, plenty of proteins During recent years, it has been found that this grain and its products produce some intoxicating effects in human beings and animals, when taken as food even after boiling. This is due to the presence of some white fungus like things present in them.

It is called "Kirukku Varaghu" due to the symptoms observed as the result of eating the husk and grain, which are suspected to contain a sort of intoxicating poison. Symptoms seen generally are inappetence, impaction, tympany, vomitting in human being after drinking water, excessive thirst, a sort of giddiness and dullness, unsteady gait and in some cases inability to get up even for 24 hours. Symptoms of madness noticed, in some cases Death occurs if not attended to immediately. Death is due to asphyxiation.

All animals are affected Donkeys suffer in an acute manner. More than 10 elephants have died Post mortem reveals the presence of the grains etc in the stomach. The disease has been produced in dogs and also in a pony by feeding experiments with the suspected material.

TREATMENT:—Plenty of tamarind water is given combined with sugar cane juice; recovery is noticed in some cases. The suspected poison is expected to be one of glucoside.

9. Seasonal Variations in HCN Content of some common crops and Tree leaves.

N. D. KEHAR *and* L. V. L. N. SASTRY, Izatnagar.

It has been observed that most of the so far known poisoning cases of livestock in India, are due to prussic acid. Observations were, therefore, made to find out the variation in HCN content of crops every month from the time of sowing till the plant was dead ripe. The following crops (Summer and winter) were examined for their HCN content Jowar, Bajra, Maize, Moong, Urd, Cowpea, paddy, Silmile, Groundnut, Til, Guar, Sanhemp, Patsan, Moth, Arhar, Barley, Alsi, Peas, Gran, Khasa, Sarsun, Wheat, Masoor, Oats and Taramira. The effect of Irrigation has also been studied. The HCN content has been noted to increase till the plant reaches its flowering stage, after which it decreases as the plant ripens. Winter crops are found to contain more HCN than the summer crops In general, it has been observed that the samples from the irrigated village contained less HCN than the corresponding ones from the non-irrigated village.

In the case of tree leaves observations were started in the month of July and extended for a period of one year, the HCN being determined at monthly intervals. It appears that HCN is maximum in the month of March and minimum in the months of May and June. Amongst the leaves examined (Pakhar, Mango, Neem, Bargad, Beri, Babul and Pipal) Pakhar appears to contain the maximum and pipal the minimum amount of prussic acid.

10. A study of the Tubercle of Whitnall in the South Indian Skull.

A. ANANTHANARAYANA AYER, Madras.

This study is based on observations on eighty adult skulls, ten pairs of zygomatic bones of children, and a series of dissection of the orbit.

The orbital tubercle of Whitnall is present in 93 per cent of skulls, and is located at a point 1 cm. inferior to the fronto-zygomatic suture. In very young children the tubercle is not marked and it gradually forms during childhood and adolescence.

Frazer (1940) considers that the attachment of the lateral check ligament is responsible for its formation. The present writer disagrees from the view. It is noted that the orbital tubercle is absent in Primates lower than man; and that it comes into form and size during childhood. The direction of the tubercle as represented by a normal at its apex is medial and not backwards. The author's dissections show, that the lateral retinaculum of Hesser is not compacted to a cord at the point of attachment; and hence it seems as if the individual moieties of the ligaments constituting the lateral retinaculum could produce varying pulls at different parts of the area of attachment. The author puts forth the suggestion that the lateral palpebral ligament is mainly responsible for the formation of the tubercle and that this strain on the lateral palpebral ligament is itself dependent on the establishment of binocular vision in men with its concomitant convergent accommodation.

11. Percursin for the qualitative replacements of blood and treatment of Tuberculosis.

J. N. MISSRA, Waini

Precursin is the medical name given to the red precursor of the like of Etioporphyrin found in the Chlorophyll II of plants. This is related to haematin of the human blood. Etioporphyrin molecules within its constitution has pyrol groups which forms Chlorophyll by a chain reaction.

The chloroplatic red pigment being glucoside in nature and formed under the conjoint acting of alkalies and oxygen is exactly like our arterial blood pigment. Thus the qualitative replacement of blood can be effected by the use of precursin. Considering the important action of Precursin on cod liver oil, I am inclined to believe that when the substance is circulating in blood in the pulmunary area and while imparting its colour, emulsifies the fatty contents of T. B. by virtue of its alkalies. Precursin is being given subcutaneously at present. The effect of this substance on the T. B. patients has been studied which shows encouraging results. Further investigations are in progress.

PHARMACOLOGY AND THERAPEUTICS

12. The Intestinal Excretion of "Phthallidine" and "Suxidine."

A. N. BOSE *and* P. C. RAKSHIT, Calcutta.

From a study on sulfaguanidine, sulfabenzide and sulfathiozole it has been shown by Bose, Ghosh and Rakhit (1946) that the efficacy of the Sulpha drug in the treatment of bacillary dysentery would depend to a considerable extent on its higher water solubility as this would have a greater chance of reacting the affected tissues. But as phthalyl—and succinyl-sulfathiazole (phthallidine and suxidine respectively) are known to have definite action against dysentery organisms without being so soluble in water *in vitro,* the mode of their intestinal excretion has been studied and the bearing of this has been discussed in relation to Marshall's hypothesis on the mode of action of sulpha drugs against intestinal infections.

In order to throw further light on the problem the bacteriostatic action and excretion of the succinyl sulphanilyl benzamide is also being studied.

13. On the Specificity in the action of Penicillin.

MARIAM GEORGE *and* K. M. PANDALAI, Bangalore.

The Gram sensitive nature of antibiotic substances is now one of their well-recognized properties. Due to the increased significance of the recent finding that the presence

of Mg. ribo nucleate is one of the criteria deciding the Gram nature of the pathogen, experiments were projected to examine the influence of this substance on the nature of penicillin inhibition on gram-negative organisms. As a result it was proved that Mg. ribo nucleate stood to gram-negative pathogens in the same relation as did ordinary nucleic acid to the gram-positive pathogens in that the added Mg. ribo nucleate antagonized the inhibitory action of pencillin on gram-negative organismas and also allowed the organisms to grow from the non viable condition rendered by contact with penicillin. The results however indicate that the addition of Mg ribo nucleate to cultures of insensitive gram-negative organisms does not help them to become susceptible to lower concentration of penicillin as would be expected. This means that Mg ribo nucleate alone cannot render a gram-negative organism allied in its nature to a gram-positive organism from point of view of susceptibility to penicillin is concerned. This, definitely shows that the specificity is a matter merely of experimental conditions and the concentration of the drug and that it can be adjusted by suitable modifications of the inhibiting environment.

The observations would also show that the Gram positive or negative character of an organism is a physiological property and depends primarily upon the differences in their metabolic reaction pathways.

14. A possible mode of action of penicillin.

M. GEORGE and K. M. PANDALAI, Bangalore.

The influence of the nucleic acids on the bacteriostatic action of penicillin was investigated in detail and the following conclusions have been reached.

Nucleic acids act as inhibitors of penicillin action. Thus parasites are able to grow even if they are in contact with penicillin provided the medium contained added nucleic acids.

Nucleic acids possess the power of restoring the viability of organisms which became non-viable after the contact with penicillin. The revived organisms grow and multiply normally.

The Gram-negative penicillin insensitive organisms under the influence of sub-lethal doses of penicillin undergo morphological changes chiefly the gram-staining characteristic. They become temporarily gram-positive.

Such gram reversing change was later found to be a fundamental one for all organisms under the influence of penicillin, for example, *Staph aureus*, *Strepto-hæmolyticus* and *B. dysenteriæ* underwent temporary gram reversals. This means that penicillin bacteriostasis is always preceded by morphological changes, especially the Gram-staining character.

It was also observed that in the case of Gram positive organisms which underwent temporary Gram-reversal the organisms could be restored to the original form by added nucleic acids; but, that, nucleic acids did not possess this property of restoring the morphological form to the reversed gram negative organisms.

On the basis of this evidence, a postulate is made that penicillin interferes in the metabolic processes of the parasites particularly in the phases where nucleic acids feature either as metabolites, helping cell division, or function as respiratory catalysts or as both.

15. Action of amidopyrine on the hæmopoietic system.

C. R. DAS GUPTA and J. B. CHATTERJEE, Calcutta.

Amidopyrine in doses of 0.04 gm. and 0.1 gm. per kg. body weight was given daily

to two groups of Rhesus monkey for 6 and 5 months respectively. There were two monkeys in each group and the drug was given orally through a stomach tube.

Examination of blood was done at intervals of 10 to 14 days for total and differential white cell counts and at longer intervals for hæmoglobin, red cells, reticulocyte and corpuscular values. No significant change was seen in the hæmoglobin, red cell count, reticulocyte and corpuscular value but slight variation in the total and differential white cell count was occasionally noted in all the animals. No definite loucopenia or neutropenia was, however, noted in any of the animals at any time.

Even in the absence of any definite change in the blood values, bone marrow findings, obtained by tibial puncture, showed definite changes at the end of the experimental period. In all the animals of both the groups, definite hypoplasia of marrow was noted, with relative and absolute diminution of the cells of the granular series and of the precursers of red cell series. Relative increase of the cells of the non-granular white cell series was however noted in all the animals, but absolute increase of these cells was observed only in the animals receiving the smaller dose—0.04 gm./kg.

16. Chloroquine (SN7618) in malaria—A report on 50 cases.

R. N. Chaudhuri, M. N Rai Chaudhuri *and* N. K. Chakravarty, Calcutta.

Chloroquine (SN 7618) is 7-Chloro-4 (4-diethylamine-I-methylbutylamino) quinolin derivative synthesised in the United States. Its properties are similar to those of mepacrine, but it possesses about three times its activity and does not colour the skin.

In this series 50 patients with active malarial infection were treated with this drug. Out of these, 18 were malignant tertian, 27 were benign tertian and one was quartan, while 4 had mixed benign tertian and malignant tertian infection. They were studied particularly with the object of finding out the time taken to control the fever, the time for the asexual parasites to disappear from the peripheral blood and side effects, if any.

The following two *schedules* of treatment were tried: (A) Two tablets (each containing 0.25 gm. of base) followed by one tablet after 6 hours and then one tablet on each of the two consecutive days—a total course of 5 tablets. (B) A single dose of 6 tablets.

Forty eight patients were above 12 years of age and received one or other of the above two schedules. Two patients under twelve years had proportionately less amount of the drug.

The average *effect of the treatment* has been (1) to bring the temperature to normal in 26.8 hours with regime A and in 26.4 hours with regime B, and (2) to cause disappearance of asexual parasites in 35 hours with A and in 31.5 hours with B. These results show that the drug is very effective in terminating an attack in a short time and is highly active against asexual parasites.

Twenty patients were under observation in the hospital for 15 to 30 days. None had a *relapse* while in the hospital. One case of malignant tertian and another of benign tertian malaria however came back with fever and homologous infection 30 days and 45 days respectively after the discharge from the hospital.

The *gametocytes* continued to appear or persist in the peripheral blood inspite of treatment.

Some *untoward effects* of the drug were observed in 5 patients. They complained of one or more of the following symptoms: insomnia, nausea and gastric irritation

pruritus and pain in the lower abdomen and thighs. These side effects were obtained with both schedules A and B, and they disappeared in 2 or 3 days.

17. Effect of vitamins on the micro-organisms of angular conjunctivitis and chelitis.

G. PANJA, Calcutta.

The growth of Morax-Axenfelds' bacillus and Petit's bacillus isolated from cases of angular conjunctivitis and chelitis is markedly inhibited by B2 complex (Riboflavin, nicotinic acid and yeast extract) and partially by vitamin B1 but stimulated by vitamin A in liquid as well as in solid culture medium, whereas the growth of typhoid, dysentery and cholera organisms, Bact. Coli. Staphylococcus, Streptococcus, Pneumococcus, Anthrax bacillus, Proteus, and Pyocyanea bacilli is practically unaffected by riboflavin. The action of riboflavin is bacteriostatic only and not bactericidal. That the two above organisms of angular conjunctivitis are pathogenic is corroborated. Riboflavin alone given internally favourably influences the disease of its marked bacteriostatic effect on the organisms.

18. Parenteral Use of Sterile Sea Water in the treatment of Certain skin diseases.

K. N. OJHA *and* K. VENKATACHALAM, Cuttack.

The injection of sea water intra-peritonially as well as intravenously has been found to effect a complete cure of cases Sarcoptic and follicular manges in canine patients and also in Ringworm infection in bovine. (Capt. K. Venkatachalam and others).

It appears that the improvement of the mineral constituents of the blood by introduction of sterile sea water makes unfavourable conditions for the parasites to live in the skin tissues.

This prompted us to try sterile sea water in human skin diseases caused by parasites. About 70 cases of typical scabies and 10 cases of Ringworm infections and 10 cases of eczamatoid lesions of the skin were selected and 3 c.c. of sterile sea water was given subcutaneously every day for 20 days.

Observations:—Itching which is so severe was absent after 3-4 days of injections and the lesions showed drying up gradually. In very mild cases the cure was within 10 to 12 days. In heavily infected cases repetition of another course was found necessary after some time. Eczamatoid lesions became dry within a week and healed up gradually within 2-3 weeks. No toxic symptoms were noticed to occur. Further work is in progress.

19. Note on Lathyrism.

M. N. RUDRA *and* H. C. GHOSH, Darbhanga.

The result of treating Lathyrism patients with daily intramuscular injections of 0.5 mg. prostigmin "Roche" is described. Given in this dosage the drug appears to have very little effect in the patients' conditions. It is admitted that the given dose is only half of what is reported to be effective.

20. The Chemical Composition and therapeutic value of the juice of fresh leaves of Peepul (aswath) tree.

S. K. Chatterji *and* H. D. Ganguli, Calcutta.

The sacred tree known as Peepul tree (aswath) is widely distributed all over India, so naturally it may be assumed that beneficial effects in some form or other may be derived from every part of the tree. So far the root, bark and fruit of the tree have gent and is used in various skin diseases and in gonorrhoea and leucorrhoea. This may been tried. The fruit is said to be a laxative and helps digestion. The bark is astrin-be due to the tannin present in the bark. The seeds are also said to be cooling and refrigerent. The juice of root is said to be a good tonic.

The green leaves have a property which is not known to many. The poorer class of people, particularly in a village where not much medical help can be received, use the juice of green leaves of the tree for the treatment of diarrhœa. They use it even in cases of suspected Cholera and with successful result. About 1 teaspoonful of the fresh juice mixed with a little sugar is administered every hour till the vomiting and purging ceases. Noting this beneficial effect, the chemical composition of fresh juice of leaves was determined.

	Small leaves.	Big leaves.	Twigs (soft) without leaves.
	p.c.	p.c.	p.c.
1. Moisture and volatile matters ..	84.56	78.58	81.06
2. Ash	3.63	4.49	1.65
3. Organic matter	11.81	16.93	17.29
Total ..	100.00	100.00	100.00
4. Hydrocyanic acid	Nil	Nil	Nil
5. Total Nitrogen	1.5	1.5	0.98
6. Protein content	9.37	9.37	6.12
7. Alcoholic extract	4.2	4.6	2.8
8. Carbohydrates	7.6	13.9	14.4

9. The mineral constituents have been found to be mainly consisting of Sulphates, Phosphates and Carbonates of Sodium, Potassium and Iron.

10. There were also traces of other salts like—Magnesium, Calcium, Copper, Manganese and Aluminium.

This has only been a preliminary step towards the investigation of the action of juice of Aswath leaves.

Investigations are still in progress to determine the effect on Cholera patients and the result will be published in near future.

PATHOLOGY, MICROBIOLOGY AND PARASITOLOGY

21. Staphylococcal antihæmolysin in normal and diabetic sera.

G. Panja *and* A. Ahmed, Calcutta.

The sera of 80 non-diabetic and 15 diabetic patients were examined for Staphylococcal antihæmolysin. 8 M.H.D. of Staphylohæmolysin active in 1 in 128 dilution was used for the test. It was found that the presence of antihæmolysin was much less in diabetic blood than in normal blood. Not a single diabetic patient showed any antihaemolysin

when the serum was diluted 1 in 64 but in normal persons 2.7 per cent. showed the presence of antihæmolysin when the serum was so diluted. When the serum was diluted 1 in 4, 97 per cent. of nondiabetics showed antihæmolysin whereas 80 per cent. only of diabetics showed it. No antihæmolysin was detectable in normal sera when the dilution of the serum was carried to 1 in 1024. There was rise of antihæmolysin content in diabetic sera *pari pasu* the fall of blood sugar during the course of treatment.

There was no appreciable difference in antihæmolysin-content before and after injections of Staphylococcal vaccine in non-diabetics, though there was generally a rise of agglutinin after injection. It is believed therefore that the presence of staphylococcal antihæmolysin is a better index of staphylococcal immunity than the staphylo agglutinin.

22. Streptococcal Septicæmia in albino mice.

V. R. Rajagopalan, Mukteswar, Kumaun.

Two outbreaks of streptococcal septicæmia in white mice were encountered during 1946-47 among the laboratory stock of mice.

The characteristic symptoms were dull and lustreless coat, hurried breathing, caseation of superficial lymphatic glands and ulceration and scab formation of the skin of the back. In some cases dry gangrene of the tail or swelling of one or both hind feet were noticed.

A hæmolytic streptococcus belonging to Lance field's group C was isolated from the lymph glands, heart blood and from all the internal organs.

The disease was reproduced in mice both by parenteral inoculation and by feeding of the cultures.

23. Utilization of ground-nut cake hydrolysate as medium for antibiotic production by micro-organisms.

R. Raghunandana Rao *and* P. R. Venkataraman, Bangalore.

A study of some of the cheaper nitrogenous raw materials to find out their use as media for antibiotic production by micro-organisms was carried out. Enzymic digest of ground-nut cake was found to serve the purpose satisfactorily. The digest is prepared by hydrolysing powdered ground-nut cake with 2% papain for about five hours at 80°C. The clear filtrate has been used in the medium after adjusting the total solids to 2%. The filtrate was analysed for total solids, total nitrogen, non-protein nitrogen, basic nitrogen, amide nitrogen, amino nitrogen, tryptophane, tyrosine, cysteine. free nicotinic acid, total sugars, potassium, calcium, iron and phosphorous. Different members of the aspergilli like *A. fumigatus, A. ustus* and *A. calvatus* and also *Streptomyces griseus* gave good antibiotic production when grown in media containing the hydrolysate.

24. Relation between Antibiotic production by Aspergillus Ustus and source of nitrogen.

R. Raghunandana Rao, Bangalore.

Experiments were carried out to find the relationship if any between the source of nitrogen and antibiotic production by *Aspergillus ustus.* The sodium nitrate of the Czapek-Dox medium was replaced by other nitrogenous materials the amount of nitrogen however remaining the same. The sodium of sodium nitrate was incorporated in the media by the addition of an equivalent amount of sodium chloride. Sulphate, Chloride and nitrate of ammonia formed the inorganic nitrogen sources, urea, aspargine and glycine the organic nitrogen sources and wheat bran extract and enzymic digest

of ground-nut cake the complex sources. Antibiotic activity and pH of the culture fluids, and weight of mycelial growth were found out daily. The experiment showed that complex sources of nitrogen favoured antibiotic production, whereas simpler sources, both organic and inorganic, favoured acid production. Growth was however more in the simpler sources.

25. The Role of Iron in the Production of Tetanal Toxin.

M. K. K. MENON, Guindy.

The vital part played by iron in any medium used for the production of Tetanus Toxin has been recognised in recent years. Attempts were made in this laboratory to find out the optimum level that is conductive to production of a high potency toxin uping *Clostridium tetani* as the strain and peptic digested beef broth as the medium. Micro-estimations of iron were made by using alfa Dipyridyl, based upon the reaction of ferrous iron with this reagent. M. L. D. determinations were made on white mice on several batches of toxin. High potency toxins were consistently obtained when the iron level was kept at about 0.125 milligram per litre showing thereby that this is the optimum level.

26. Studies in Anthrax transmission.

B. C. BASU, Izatnagar.

The role of arthropods in the transmission of Anthrax is under investigation. Experiments were tried on guinea-pigs. The arthropods which are being tested are: *Musca* (mostly *nebulo*), *Culex*, sp., *Acdis albopicta, Anophelis annularis, Hæmatopinus tuberculatus, Hyalomma ægyptium. Argas persicus, Ornithodorus savignyi, Ornithodorus crossi, Ctenocephalus felis* and *Tabanus rubidus.*

Three types of mosquitoes, buffalo lice, *Argas* and *Ornithodorus* ticks and *Tabanus* flies failed to transmit the disease by interrupted feeding (i.e., half feeding on an infected guinea-pig and refeeding on a healthy one immediately afterwards). *Musca* flies (upto four hours through abraded surface). *Hyalomma* ticks and *Ctenocephalus* fleas could transmit the disease by interrupted feeding.

Survival of Anthrax organisms in the gut of the above arthropods have been studied. They survive upto forty hours in *Musca*, one hour in mosquitoes, forty-eight hours in *Ornithodorus*, fifteen days in *Argas*, forty-five hours in *Hyalomma* and twenty-four hours in *Hæmatopinus* and *Ctenocephalus*.

Culicine larvæ developing in water containing Anthrax spores yielded adults with guts non-infected with Anthrax. Anthrax organism survives for fourteen days (or longer) in the gut of earthworms, feed artificially with Anthrax spores.

NUTRITION AND BIOCHEMISTRY

27. Effect of prolonged administration of Intermediary metabolites on the blood-sugar level of rabbits.

M. C. NATH *and* H. D. BRAHMACHARI, Nagpur.

Sodium salts of the Intermediary fat metabolism products (viz., acetoacetic acid, B-hydroxy-butyric acid) while injected daily in the normal rabbits, gave rise to the condition of hyperglycemia after a certain period.

This state of hyperglycemic condition does not persist for long, and after a particular time the blood sugar values begin to fall down if the daily dose is not allowed to be increased.

By gradual increase in the doses of these compounds it has been possible to maintain a typical type of hyperglycemia charcterised with decreased sugar tolerance as in case of clinical diabetes mellitus.

Glycosuria and acetonuria have been observed along with hyperglycaemia in the animals receiving injection of gradually increased doses of B-hydroxy butyrate.

28. The test of detoxicating function of liver by sodium benzoate injection in normal and allergic states in Indians.

G. PANJA *and* S. BANERJEE, Calcutta.

Exactly one hour after an intravenous injection of 1.77 gm. of sodium benzoate (equivalent to 1.5 gm. of benzoic acid) dissolved in 20 c.m. of distilled water, the excretion of hippuric acid calculated as benzoic acid was tested by the method of quick allergic states such as atopic dermatitis, eczema, etc. In the normal group, all were adult males; average excretion was 0.701, the range varying from 0.23 to 1.22 as compared with the English figures, average 0.768, range 0.41 to 1.10 based on 20 females cases only; American figures—range 0.72 to 0.95. In the group with allergic states, the average excretion was 0.62, the range varying from 0.23 to 1.09 (33 adult males and 5 adult females).

The figures statistically examined show no significant difference between the control and the test cases, indicating thereby the possibility of absence of any role of the liver in its detoxicating function in the allergic states.

The average normal Indian figures are given in the paper.

MISCELLANEOUS

29. Note on Lall's nitric acid test for mustard oil.

M. N. RUDRA, Darbhanga.

Lall's nitric acid test has been found to be useless for detecting adulteration of mustard oil with Argemone mexicoena oil.

30. Observations on Sera of normal population in Bombay.

MRS. S. D. SOMAN, Bombay.

Analysis of 1042 sera submitted to W. R. and Khan and 6492 to standard Kahn test are presented. Of 1042 sera submitted to the two tests, discrepancies are noted in 25% of all reacting sera; this compares favourably with the findings of other worker. Of these 16.9% were due to W. R. +ve and Kahn —ve and 8% were due to W. R. —ve and Kahn +ve . The former is twice that of the latter in this series, while the results of other workers indicate that these two kinds of discrepancies are equal. This may be due to the smaller and selected number of sera submitted to both the tests in the present series. It is noted, however, that W. R. is more sensitive, *i.e.* 9.7% than 5.8% sensitivity of Kahn test. From the available history of cases it appears that most of the W. R. +ve are syphilitic cases and the discrepancies are mainly in these. The incidence of Kahn +ve is in confirmity with reports of other workers.

Blood donors in other countries usually represent random samples of population and this accounts for a very insignificant, 0.75%, to 0.9% positive rate in general population (Br. Jour. of Veneral Diseases, June 1944). The sero-positive rate in blood donors in the present series is 5%. Greval, from his experience in Calcutta, states that sero-positive rate for the general population must be very low and the sero-positive rate indicative of syphilitic infection insignificant.

31. Cation-Exchange resins for recovery of Quinine.

N. KRISHNASWAMY RAO *and* K. VENKATARAMAN, Bangalore

The serious shortage of quinine caused by the World War II has been sought to be countered by extending the area under cultivation. Improvements in methods of working the bark would offer immediate results.

Ion-exchange resins which can be used in acid medium can be employed for the recovery of quinine from acid extracts of the bark on a continuous cycle. The portable nature of ion-exchange units and the fact that the wet bark gives (Applezing 1944) a larger yield of quinine makes it possible to work the bark in the plantations thus avoiding the troublesome process of drying and costs of haulage and powdering.

As a preliminary to investigating the possibility of employing such a method we decided to study the capacity (for absorption of quinine) of a resin prepared by one of us from a local tanning bark (Cassia Auriculate). Percolation of a weak (0.2%) solution of quinine sulphate through a column of the resin showed a capacity to "break through" of 11 gms. per 100 c.c. resin bed. Parallel experiments with an American product ("amberlite I R. 100") gave a capacity of 13 gms| 100 c.c. Organic solvents could be used for elution but we have found that aqueous ammonia is also satisfactory.

Further work is in progress to study the recovery from Cinchona bark and to investigate the possibility of evolving simple methods for the separation of quinine from the associated alkaloids.

32. Removal of fluorides from water.

K. VENKATARAMANAN, N KRISHNASWAMY RAO *and* T. RAMAKRISHNA NAIR, Bangalore.

Fluorosis is endemic over several areas of our country. The main source of ingested fluorine appears to be the drinking water While there is evidence that nutritional supplements can mitigate the severity of the symptoms, a more direct and practicable approach would be to reduce the fluorine content of the water.

A large variety of methods have been investigated from the point of view of our local conditions which make cheapness and simplicity of operation the more over-riding requirements. The use of paddy husk carbon treated with alkali and then with aluminium salts appears to be promising The fluorine-containing water is merely percolated through a column of this carbon. The exhausted material can be regenerated by percolation of a solution of alum.

The following are among the other materials discussed: Bone, Bone charcoal, tricalcium phosphate, superphosphate, various carbons with and without activation, Aluminium phosphate, Aluminium silicate, natural clays, calcium aluminate, cation and anion exchange resins, and cation exchange resins charged with Aluminium ions.

33. The problem of brackish Water.

K. VENKATARAMANAN *and* C. P. NATARAJAN, Bangalore.

Rural areas and many urban area in the Presidency of Madras depend on wells for their supply of drinking water. In many areas where the wells yield brackish water, the problem of obtaining palatable drinking water is acute.

This problem can be approached in several ways viz (a) to seek an explanation for the occurrence in close proximity of fresh and brackish-water wells and to investigate if the adsorptive or other processes in the intervening soil play any part in the reduction of the brackishness of the water; (b) to investigate methods which would enable us to tap fresh water and avoid the intrusion of brackish springs and (c) to

devise simple methods of treatment to convert brackishwater into "sweet" water. The possibilities in each of these directions have been examined. A variety of materials have been prepared and studied for use as cation and and anion exchangers. Resins obtained by condensation of the extract of tanning barks (Cassia auriculata & Wattle bark) with formaldehyde have shown good capacity which has not suffered on continuous use (with regeneration) over a period of 2 years.

34. A chemical test for detection of the active principle of gloriosa superba in human and animal tissues.

S. K. CHATTERJI *and* H. D. GANGULI, Calcutta.

Gloriosa superba an ornamental creeper plant, belonging to the N. O. Leguminosee is quite common in Bengal and in low jungles throughout India. Its flowers are used by the Hindus in the worship of "Shiva". The white juicy tuberous roof which is more or less flattened or cylindrical in shape often 7-8 inch. in length and about 1 inch. in diameter (when fully grown) is considered as one of the seven minor poisons of sanskrit writers. It is often mistaken for aconite root and used as an adulterant of aconite. Besides, tannin and resin it contains a bitter principle which has been termed "Superbine".

It is known to have been used as a poison both as a suicidal as well as an abortifecient with fatal results. The symtoms were like those of an irritant posion viz., Nausea, Vomiting, diarrhæa, Convulsions, profuse sweating, coma, collapse and death. On post mortem examination the internal organs like stomach intestines, lungs, liver and kidneys were all found to be congested.

No definite chemical test for its detection in the human and animal tissues is to be found in any toxicological text books. Attempts had therefore been made to find out a suitable chemical test to detect the active principle of the plant in human and animal tissues in a fatal case of poisoning by it. Several experiments were conducted and the following results were noted:—

1. An acid chloroform mixture was found to be the most suitable agent for extraction of the poison from a sample of dried powder root.

(*N. B.* An acid or alkali ether extract or an alkali chloroform extract was not found to be suitable for the purpose).

The residue obtained on evaporating the acid chloroform extract of the dry powdered root was then tested.

a. Taste — Bitter.
b. Mayer's — Negative.
c. With Hcl or H_2SO_4 — a deep yellow colour.
d. With $H_2SO_4 + K_2Cr_2O_7$ — no colour.
e. With $H_2SO_4 + KNO_3$ (crystals) — violet colour changing to red.
f. With conc. HNO_3 — a deep violet colour with a yellow tinge appearing on the margin.
g. With Fehling's solution — slight reduction.
h. Injected to frog — proved fatal.

2. Powdered root mixed with minced meat, kept overnight then soked in rectified spirit with a few drops of acetic acid for 24 hours and extracted by stas Otto method using acid chloroform mixture and the residue tested. The same results were observed as above.

3. Powdered root mixed with minced human viscera (received from morgue from cases of natural death from injury)—kept overnight, then treated in the similar way as above and the residue tested—The same observations were made.

4. Powdered root mixed with minced human viscera + 0.2% Hcl (soln.)—kept in an incubator for 24 hours at 37° C and then for 3 days at room temperature and treated in the same way as above.—The same observations were made — the nitric acid test gave a positive test though not so marked as in the dry powdered root.

Thus an acid chloroform mixture was found to extract the whole amount of the active bitter principle from the poison using Stas Otto method. It is not alkaloid in nature but a glucoside, fatal to a frog when injected to it, gives a positive colour test with HNO_3 with H_2SO_4 and H_2SO_4 + KNO_3 crystals.

Veterinary Section

Medicine, Pathology, Microbiology and Parasitology.

35. Blood picture in Ranikhet Disease of fowls.

G. L. Sharma *and* C. Seetharaman, Mukteswar, Kumaun.

In view of the scanty literature about the blood picture of fowls suffering from or infected with Ranikhet Disease, blood picture of fifteen healthy Rhode Island Red fowls, infected artificially with virulent strain of Ranikhet Disease virus, has been studied.

Blood of each fowl was collected from the heart, before and after the infection, and examined for (1) total erythrocyte count, (2) total leucocyte count, (3) corpuscular volume, (4) sedimentation rate, (5) differential count of white blood cells, and (6) hæmoglobin estimation. Total erythrocyte and leucocyte counts were made by using Toisson's fluid as a diluent; while making differential count of white blood cells, 'edge' and 'cross section' methods of examining smears were combined.

During the disease there is an appreciable fall (1) in total erythrocyte and leucocyte counts and (2) in the hæmoglobin percentage. The differential count shows a distinct rise and fall in the percentage of heterophiles and lymphocytes respectively.

36. Rinderpest in Dairy Cattle immunised with goatis.

P. R. Krishna Iyer, Izatnagar.

A valuable stock of dairy animals (milch buffaloes, cows and young stock) property of Messrs. Govan Bros., Rampur were immunised against rinderpest with goatis in May 1945. Fifteen months later, many of these animals contracted rinderpest from the animals in the surrounding villages where this disease was raging and succumbed. Prompt serumisation of the entire farm stock followed by a second vaccination effectively put a stop to the disease.

Experiments at Mukteswar indicate that cattle immunised with goatis develop a life-long immunity. But this Rampur incident is not exactly in accordance with the findings at Mukteswar. The causes of the break-down in the immunity are discussed.

37. Infectivity by contact of Rinderpest Virus, including Goat-adapted Virus for Cattle and Goats.

C. SEETHARAMAN, Mukteswar, Kumaun.

Experiments were made to test the infectivity of rinderpest virus—both the virulent bull virus and goat adapted virus—from cattle to cattle and goats and from goats to cattle and goats, under ordinary field conditions and under conditions some of them admittedly artificial which would enhance the chances of transmission.

To represent various degrees of contact experiments were made in an ordinary cattle shed, in a small room of ten feet square, where still closer contact between healthy and infected was possible and in a trevis where the healthy and infected face each other at a distance which can be varied at will, the apparatus being covered with a thick tarpaulin so that the healthy inhaled the expired air of the infected.

The results of these experiments showed that a healthy bull infected with goat virus failed to transmit the disease in any case either to bulls or goats. However a healthy goat infected with goat virus was found to transmit the infection only to a healthy goat under very close contact as in the trevis. With the virulent rinderpest virus it was found that whereas transmission was possible from goat to goat and bull, transmission did not occur from bull to goat. It is concluded that there appears to be no danger of spread of the disease occuring through the use of goat virus in the field.

38. Ranikhet Disease outbreak at Izatnagar.

S. G. IYER, Izatnagar.

Ranikhet disease, caused by filterable virus, broke out on the Military Poultry Farm in the month of January 1946 and took a heavy toll of over 3,000 birds. None of these birds had been previously inoculated with the egg passaged vaccine. Almost simultaneously a few cases of Ranikhet disease were diagnosed in 3 pens on the Institute Farm adjacent to the above farm where 26 non-vaccinated and 22 vaccinated birds were present. More than 65 per cent. of the former succumbed to the disease but not a single vaccinated bird died.

39. Immature amphistomiasis in sheep in the Government Cattle Farm, Hosur.

P. R. KRISHNA IYER, Izatnagar.

The veterinary authorities in Madras were worried by an undiagnosed disease which occurred year after year among the flock of sheep at the Hosur Cattle Farm. The disease had a seasonal incidence from December to March and it was responsible for many deaths. The main symptoms were intermaxillary œdema, discharge from the nostrils and acute diarrhœa resulting in death in about a week. Post-mortem examination revealed acute congestion of the abomasum and to a lesser extent in the intestines.

Investigation by the writer conclusively proved that the disease was one of immature amphistomiasis. The lesions on the gastric and doudenal mucosa which were passed off for mere acute congestion were found to be uninterrupted congregations of immature amphistomes numbering about 200 to 500 per sq. inch imbedded on the inflammed mucosa.

40. Intestinal Trichomoniasis in calves.

N. S. SANKARANARAYAN, Izatnagar.

During the course of investigation of calf scour in a well organised farm the complaint was found to be not the classical white scour that generally occurs in young calves although the symptoms were identical. The disease started with diarrhœa, rise of temperature, slow feeding of milk, dysentery with discharge of mucus and blood and the

animal dying from exhaustion. The post-mortem lesions were mostly confined to the small intestines in the form of acute enteritis with ulceration and hæmorrhage. Liver was found affected to a certain extent. No complications as naval ill, joint ill or pneumonia which are common in white scour were present. Blood and organ emulsion failed to infect small animals. Series of microscopical examinations carried out revealed actively moving *Trichomonas* in fæces samples of sick animals, samples of water from water troughs and supply tanks. Sporadic cases of diarrhœa in bigger animals also showed similar flagellates which invariably disappeared either on recovery of the animals or when dysentery intervened. Treatment of the affected animal with an anti-protozoan drug gave relief with the disappearance of the parasites. The outbreak stopped practically with the cleaning of the well and the tank. Untreated cases were found to be affected by secondary bacterial invaders as *B. coli* and *pseudomonas ærogmosa* which were responsible for the dysentery and death. *Trichomonas intestinalis* although encountered in bovines and considered as non-pathogenic, from reports on this subject and from the above findings it is assumed that they are capable of causing intestinal disorders in calves under favourable conditions.

41. Stephanofilariasis among Buffaloes in Assam.

V. R. Gopalakrishnan, Assam, Gauhati.

Details are given of investigation of Stephanofilariasis in buffaloes and of its occurrence as a specific cutaneous microfilariasis of the ear. The disease usually occurs sporadically but at times, it prevails in the form of an epidemic Full particulars of its seasonal occurrence and localities affected are given.

Symptoms, course, means of control and treatment are described The disease is generally confined to buffaloes. It is very rarely fatal though the incidence of affected animals in an outbreak varies from 20 to 50 per cent

The casual parasite, both microfilaria and adult nematode, has been recovered from the lesions of ear-sore. The morphological characters of the parasite have been found humpsore of cattle in India. The findings have been confirmed by Mukteswar Institute apparently identical with those of *Stephanofilaria assamensis* (Pande 1936), causing and by Officer-in-charge, Helminthiasis Scheme, Lucknow University.

Skin affections of cattle in India and elsewhere, caused by *Stephanofilaria sp.*, are cited. The occurrence of *Stephanofilaria sp.* in buffalo-a different species of animal causing ear-sore, is recorded and its significance is pointed out.

Observations on certain identical features of hump-sore of cattle and ear-sore of buffaloes are discussed.

The work has been carried out under a scheme of research financed by the Imperial Council of Agricultural Research, India.

42. Johnes' Disease in Animals in the Madras Presidency.

G. R. Viswanathan, Madras.

The incidence of this disease is known to exist in the two farms of Coimbatore and Hosur for a very long time. The incidence of the disease in the following other places also are on record namely Bangalore, Military Dairy farm, Wellington, Central jail Vellore, in Mangalore, Ooty dairy, Nanjanad farm and also in Devakottah. The disease has been known to occur in cows, heifers, bulls, bullocks, buffaloes, sheep and rams. The disease runs a very acute course after parturition. Remarks are offered concerning the spread and control of the disease. Investigations are in progress concerning the breed susceptibility of cattle, their sex and age.

43. Bovine Tuberculosis in the Madras Presidency and its Diagnosis by Tuberculin test.

G. R. VISWANATHAN, Madras.

Organised attempts in Madras to find out the incidence was made by the author only in 1934. The method adopted from 1934 to 1936 was single intradermal method and from 1942 to 1947 it was double intradermal method. 514 animals were tested by the single intradermal method, only 4 gave suspicious reaction, while the rest were negative. This was done in the mofussil. From the results obtained, it would appear that the incidence of the disease in smaller towns of this presidency is rather rare. The number tested is so meagre as to have any definite conclusion. In Corporation cattle about 37 per cent. infection detected. An account of the comparative incidence in the Ongole and Mysore cattle is given. The variations in the percentage of infection in the different depots of the Corporation are noted. Post-mortems conducted together with the results are furnished.

44. Some observations on Avian Pasteurellosis (fowl cholera) outbreaks.

S. G. IYER, Izatnagar.

Fowl cholera (avian pasteurellosis) first broke out in the Institute's popultry farm in 1940. It re-appeared in the subsequent years causing the death of only a small percentage of the stock during each year. Although the first cases of the disease occurred during the hot summer months in all the years, the incidence was greatest during the monsoon period (July to Sept.). There were thousands of chickens in the brooder houses on the same farm but the disease has not occurred in them, the cases mostly occurring in the rearing pens. In some pens (rearing) only one or two birds died while in others 50 per cent. of the stock was wiped out within 2 weeks from the commencement of the outbreak. Recurrence of the disease on the farm year after year is attributed to the existence of "carriers" in the flock.

Methods for diagnosing the condition are described.

Serum and Vaccine inoculations were carried out and the results indicate that there is considerable scope for improvement in the preparation of these products.

45. Investigation on Contagious Abortion in Goats with Special Reference to Isolation of Brucella Abortus (Bang) from Goats' Milk.

P. R. NILAKANTAN *and* P. G. PANDE, Mukteswar, Kumaun.

Brucellosis amongst goats at the Government Livestock Farm, Hissar in the East Punjab, was investigated by blood serum agglutination test and by cultural examination and guinea-pig inoculation of the infective materials including milk.

Brucella abortus (Bang) was isolated from 3 out of 5 guinea-pigs inoculated with milk samples from different goats whose blood serum gave positive reaction on agglutination test for *Brucellosis*. The following methods were used for identifying the type of *Brucella* involved:—growth under 10 per cent. CO_2 tension, growth on Huddleson's dye media, H_2S production and agglutinin-absorption test.

This is the first authentic record in India of natural infection of goats with *Br. abortus* and is an addition to the meagre information available of *abortus* infection in goats.

46. Application of allergic test in the detection of latency of surra in bovines artificially infected with *Trypanosoma evansi.*

H. N. RAY, Mukteswar, Kumaun.

In this article the author for the first time describes in detail some experimental observations made on the utility of allergic test in diagnosing latent surra. (*T. Wansi* infection) in cattle.

White rats were used for the yield of *Trypanosoma evansi* for preparing antigen. 0.1 c.c of a dilute suspension (1|4000) of dry surra antigen made in saline was introduced intradermally and the reaction noted between the sixth and ninth hour. In positive cases there was a typical swelling which was characterized by heat and pain while the negative controls no such reaction was evidenced. At the end of 24 hours the swelling persisted in the positive ones while in the negative cases the site of inoculation was almost completely obliterated.

The utility of this test in the control of surra in this country has been discussed.

47. Application of Electrocardiogram in Animal Husbandry.

D. N. Mullick, Izatnagar.

Electrocardiogram is used extensively in the health and disease in human beings but little work has been done in animals. Experiments were therefore undertaken in sheep. In one group the thyroids were removed by operation. Daily E K G records were taken in experimental and control groups for 13 weeks. All the waves of P Q R S and T gradually decreased with time. The heart beat was slowed down. At this stage the thyroidectomised animals were supplimented with synthetic thyroprotein and the control was fed with thiouracil, a thyroid depressing drug. In thyroprotein group, the potential of all waves returned to normal within a week, with an increase in heart beat. The thiouracil group showed a decrease in heart rate with increase in potentials of Q R S and T.

Physiology, Nutrition and Biochemistry.

48. Factors affecting temperature records of domesticated animals in health.

N. S. Sankarnarayan, Izatnagar.

In recording body temperature of healthy animals if variations are noticed without manifestation of any clinical symptom, it was found mostly due to the faulty manipulation of the thermometer or spurious records of inaccurate instruments or to the temporary disturbances caused to the animal body by sudden change of its environment. To record the maximum unchanging temperature of healthy animals if the ordinary clinical thermometer is used it should be introduced in its full length leaving only a portion sufficient to hold with two fingers. This gave always a constant figure. Introducing the index finger along with the thermometer contributed to a great extent in reducing the rectal temperature and the subsequent record. Temperature recorded after exposure of animals to the sun was found to be always higher by 2 or 4 degrees than the normal depending upon the period of exposure and the nature of the sunlight. At least an hour's rest in the shade should be given before the correct figure is obtained. Watering reduces the temperature to an appreciable extent and the effect of watering remained for two hours in cattle and about one hour in horses and the correct record was obtained only after these periods.

49. Physiological studies on the blood of Domestic Animals.

Part II. Adult male buffaloes.

N. D. Kehar and V. N. Murty, Izatnagar.

In locating the pathological conditions, normal standards of the various blood constituents under different physiological conditions is extremely essential. In this article which forms the second of the series, observations on adult male buffaloes are presented The blood was analysed for the following constituents. The maximum, minimum and the average figures are given:—Hæmoglobin (6.1-9.3) Av. 7.7 gms. per 100 ml. blood. Red Blood Cells (4.4-7.2) Av. 6.1 millions per cmm. Cell Vol. (24.5-44.5) Av. 35.5 per cent.

Mean Corpuscular Vol. (52.2-67.3) Av. 58.4 cu.m.
Mean Hemoglobin concentration. (11 0-14-2) Av. 12 7 11.
M. C. H. (19.6-25.4) Av. 21.8 per cent.
Calcium (9 4-11.0) Av. 10.0 mg. per 100 mg. serum.
Inorg. Phosphorus (5.76-7.84) Av. 6.95 mg. per 100 ml. serum
Magnesium (2.14-3-45) Av. 2.76 mg. per 100 ml. serum.

50. Physiological studies on the Blood of Domestic Animals.

Part IV. Buffaloes calves.

N. D. KEHAR, C. V. RAO and V. N. MURTY, Izatnagar.

Samples of blood from six buffaloes calves were analysed from the birth to the age of one year at fortnightly intervals for morphological and chemical constituents. The calves were born with high blood sugar, Potassium, and calcium content. A gradual fall in these constituents has been noticed till the fourth month, and there-after remained almost constant. Magnesium, sodium, and chlorides gradually increased with age (5 to 6 months) till the sixth month. The low Inorg. Phos. at birth although higher than their dams, reached the peak level by the third month. The abnormally low serum proteins on the first day of birth, reached the maximum by the 1st week and maintained the level with slight fluctuations. The highest concentration of the Hb. R.B.C., C.V., and W.B.C., observed between 12th to 16th week, has shown a steady decline till 20th week, and remained steady at that level.

51. Physiological studies on the Blood of Domestic Animals.

Part V. Goats.

V. N. MURTY and N. D. KEHAR, Izatnagar.

In view of the scarcity of any data on the composition of the blood of goats, a systematic study was made on thirty growing, healthy young (9-18 months) male goats. The blood has been analysed for the morphological and chemical constituents. The maximum, minimum and average values are given below:—

H.B (4.9-8.2) Av. 6.7 mg per 100 ml. of blood.
R.B.C. (8.0-15.9) Av. 12.7 millions per c. mm. blood.
C.V. (19.9-36 9) Av. 29.8 per cent.
M.C.V. (16.2-30.3) Av. 23.6 Cu. m.
M.C.H. (4.3-6.6) Av. 5.3 r.r.
M.C.H.C. (18.4-26.8) Av. 22.7 per cent.
W.B.C. (10.2-21.8) Av. 15.5 thousands per c.mm.
Serum Proteins (4.2-9.2) 6.86 gms., per 100 ml. serum.
Sugar (63.6-105.8) 83.5 mgms. per 100 ml. serum
Ca. (9.2-11.8) 10.3 mgms. per 100 ml. serum.
Inog. Phos. (3.4-9.9) 6.5 mgms. per 100 ml. serum.
Mg. (1.8-3.2) 2.5 mgm. per 100 ml. serum.
Na. (230-541) 431 mgm. per 100 ml. serum.
K. (11.3-20.8) 14.1 mg. per 100 ml. serum.
Chlorides (404-468) 437 mg. per 100 ml. serum.

52. Physiological studies on the Blood of Domestic Animals.

Part VI. Kumaoni Bullocks.

V. N. MURTY *and* N. D. KEHAR, Izatnagar.

In view of the paucity of knowledge on the blood of bullocks and its importance in physiological and pathological studies, a systematic work on the blood composition of twenty four healthy kumaoni bullocks has been carried out. The average normal figures and the range of the following constituents is given below :—

Hb. (6.2-9.2) 7.4 gm per 100 ml. blood.
R.B.C. (4.4-8.4) 6.5 millions per c.mm.
C.V. (24.6-46.2) 35.3 per cent.
M.C.V. (43.4-63.5) 54.6 Cu. m.
M.C.H. (10.1-14.3) 11.6 r.r.
M.C.H.C. (19.-25.3) 21.2 per cent.
W.B.C. (6.4-11.9) 8.4 thousands per c.mm.
Ca. (9.4-11.4) 10.5 mgm. per 100 ml serum.
Inorg Phosphorus (4.8-8.3) 6.8 mgm. per 100 ml. serum.
Mg. (1.71-3.19) 2.35 mgm. per 100 ml. serum.
Na. (253-480) 360 mgm per 100 ml. serum.
K. (11.9-16.5) 14.0 mgm. per 100 ml. serum.
Chloride (344-412) 385 mgm. per 100 ml. serum.
Serum Proteins (5.1-8.9) 6.79 mgm. per 100 ml. serum.
Sugar (70.6-102.3) 88.1 mgm. per 100 ml. serum.

53. Hæmatological observation in Indian sheep and goat.

D. P. MUKHERJEE *and* P. BHATTACHARYA, Izatnagar.

Previously observations were recorded on the correlation of seasonal influence on semen characteristics and some blood constituents, hæmoglobin and cell volume in bulls. It was desired to continue this study on sheep and goats as well. As no normal data regarding the blood compositions of Indian breeds of these species are available, a study was undertaken to determine these morphological constituents.

Bi-weekly examination of blood samples have been made from nine sheep and eight goats from August 1946 to July 1947. Standard methods were employed in determining the constituents. The period of observations have been divided into four seasons that is, autumn, winter, spring and summer. Season wise the mean values of hæmoglobin and cell volume of goat are 6.24, 6.53, 6.91 and 6.66 gm. per 100 ml. of blood and 30.41, 30.60, 31.39 and 30.97 per cent respectively. In sheep the values are 6.91, 7.76, 7.87 and 7.69 gm. per 100 ml. of blood and 32.99, 33.86, 34.79 and 34.32 per cent respectively.

54. Copper Content of Blood and Tissues of Nermal Kumauni Bullocks.

K. SAHAI *and* N. D. KEHAR. Izatnagar.

Copper content of blood, liver, spleen, bonemarrow, lymph gland and pancreas of normal kumauni bullocks ranged between 0.135—0.153, 160.6—200.1, 15.6—19.2, 24.6—28.8 and 19.2—24.0, with an average of 0.141, 173.6, 17.2, 26.6, 37.1 and 22.0 mg. per kg. respectively. The results indicate that of all the tissues examined liver is the richest and spleen the poorest in copper. In the descending order of copper content, liver is followed by lymph gland, bone-morrow, pancreas and spleen. The copper content of blood of kumauni bullocks has been found to be within the range obtained for the blood of man and most of the other animals. The high copper content of liver suggests that this organ is the chief storage centre of copper in the animal body.

55. Minimum and optimum Copper Requirement of Kumauni Bullocks.

K. SAHAI *and* N. D. KEHAR, Izatnagar.

The minimum copper requirement of kumauni bullocks, calculated from three sets of animals fed at different levels of copper, ranged from 6.56 to 6.87 with an average of 6.69 mg. of copper per 100 lbs. live weight per day. It was observed, however, that optimum results from a feed consisting of wheat straw and rape cake were obtained when the intake of copper by supplementation with copper sulphate, was raised to 7.38 mg. per 100 lbs. live weight, per day, which is about 10 per cent higher than the minimum requirement level. This has been termed the optimum copper requirement of kumauni bullocks.

The concentration of copper in the feed, calculated on the basis of the ingestion of copper and consumption of dry matter corresponding to the minimum and optimum copper requirement of kumauni bullocks, works out at 7.3 & 8.0 p.p.m. of the ration on dry weight basis.

56. Fishmeals as Cattle-feed; Digestibility and Nutritive value of Fishmeals

S. S. NEGI *and* N. D. KEHAR, Izatnagar.

In India fishmeals are not economically used at present; nor do we possess sufficient information with regard to their nutritive value.

The nutritive value of two fishmeals, *viz.*, salted mackerel and beach dried manthal, was determined by feeding these meals, with wheat *bhoosa* as roughage, to kumauni bullocks. It has been found that in general the animals start relishing the meal after three or four days. The digestibility coefficients of the two main constituents *e.g.*, crude protein and ether extract were 60 and 114 respectively for salted mackerel and 68 and 82 were the corresponding values for beach dried manthal. In salted mackerel the D.C.P. D.E.E., T.D.N. and S.E. per 100 lbs. of the material were found to be 37.95, 6.40, 52.4 and 50.1 respectively and in beach dried manthal the respective values were 48.93, 2.93, 55.4 and 52.5.

57. Investigations on Famine Rations: Jaman seed as a Cattle feed.

N. D. KEHAR *and* KARTA SAHAI, Izatnagar.

The chemical analysis of Jaman seed indicated that it is fairly rich in crude protein and the calcium content too is fairly high.

Adult kumauni bullocks were fed on wheat straw and a concentrate mixture consisting of 3 parts of jaman seed and one part of rape cake, for a period of thirty weeks. These adult animales which ordinarily maintain weight, gained on an average about 32 lbs. on the experimental ration.

Results of a metabolic experiment showed that the animals were on a high positive balance with respect to nitrogen. The balance for calcium and phosphorus too was positive. The digestibility coefficients of crude protein, ether extract and total carbohydrate were 68.5, 72.2, and 60.3 respectively. The digestible nutrients and starch equivalent per 100 lbs. of dry matter were found to be 45.5 and 45.1 respectively. This B. V. of the protein worked out at 84.3.

These observations give jaman seed a fair place in the list of concentrates. The digestible protein is fairly comparable to other seeds and grains, and jaman seeds can be satisfactorily used to replace oil cakes to the extent of at least 75 percent. The keeping quality of the seeds seems to be satisfactory as no deterioration took place even after twelve months storage. It is believed that this new source will provide several million maunds of concentrate food for cattle every year.

58. Investigations on Famine Rations: Groundnut Husk as Cattle feed.

N. D. KEHAR *and* L. V. L. N. SASTRY, Izatnagar.

Acacia Arabica grows extensively over a large area in India. Its pods are not economically utilised and much less the seeds. On chemical analysis the crushed pods were found to contain 14 per cent crude protein, 1 per cent calcium and 0.17 per cent phosphorus. Digestibility trials on Kumaoni bullocks indicated that the digestible protein, starch equivalent and total digestible nutritients are 10.5, 64.3 and 75.5 lbs. per 100 lbs. respectively. The metabolism trial also shows that the animals are in positive balance with respect to nitrogen calcium and phosphorus. Morphological and chemical examination of the blood of animals fed on acacia pods for a long period, showed no deviation from the normal values. These observations place acacia pods in the category of concentrates like gram, maize etc. for livestock.

59. Investigations on Famine Rations: Acacia pods as Cattle feed.

N. D. KEHAR *and* S. S. NEGI, Izatnagar.

It was suggested whether groundnut husk, major portion of which is thrown away as a waste could be used for feeding cattle. On chemical analysis the husk was found to contain crude protein 6.56, crude fibre 66.31, N. F. E. 22. 16, lime 0.27 and phosphate 0.20 per cent. It was found that groundnut husk would not be consumed to form the total roughage quota and hence the ration including a concentrate, was so formulated that wheat *bhoosa* formed approximately one third of the total roughage supply. Feeding trials with *Kumaoni* bullocks indicated that the digestibility coefficients of crude protein, crude fibre and N. F. E. were 25, 19 and 41 respectively. The digestible nutrients in lbs. per 100 lbs. of the dry husk were: D. C. P. 0.91, D. C. F. 12.60, D. N. F. E. 9.21, T.. D. N. 23.82 and S. E.—14.76.

The low digestibility of crude fibre and hence the negative starch equivalent may be due to the complex deposition of lignin in the cellulose structure. Further work aiming at the loosening of the ligno-cellulose complex is in progress.

60. Investigations on Famine Rations, Bawar (*Cassia Tora, Linn.*) Seed as concentrate feed for livestock.

N. D. KEHAR *and* V. N. MURTY, Izatnagar.

Bawar which grows in abundance during the monsoon months is not economically used. Its seeds were analysed toxicologically for the various toxic pronciples and chemically for the organic and inorganic consituents. This chemical composition of the seed showed that it contained 21.12 per cent of crude protein, 7.75 per cent of ether extract, 64 5 per cent of total carbohydrates, 5.56 per cent of sol. ash, 1.22 per cent of Cao and 1.62 per cent of P_2O_5. The seeds are not relished if they are fed as a single concentrate, but when mixed with rape cake in equal proportions, the animals get soon accustomed to it and develop a tests after a few days. Digestibility trials conducted on three kumauni bulls showed the following digestibility coefficients:—crude protein 78.8, ether extract 88.1, total carbohydrates 42.5, 54.3, Starch equivalent, 59.4, total digestible nutritients. The digestible nutritients per 100 lbs. of dry seeds are:—crude protein 16.64 lbs. ether extract 6.83 lbs. total carbohydrates 27.41 lbs. These observations indicate that Bawar seed is as good as some of the ordinary cakes eg (cocoanut, linseed).

Bawar seeds were fed at the rate of 50% of the total concentrate mixture for a period of five months without any adverse effect on the health of the animals. During the latter part of the feeding period, a detailed study of the blood composition was carried out, and it was found that the blood of these animals did not in any way vary from those of the normal animals.

61. Further study on seasonal variations of semen in goats.

D. D. SHUKLA *and* P. BHATTACHARYYA, Izatnagar.

As a result of further works it has been found that 'reaction time' was highest in winter and during the rest of the seasons it was fairly uniform. On an average the semen samples were thick creamy during winter and spring and thin creamy during summer and autumn. Average size of the ejaculate was largest in summer and smallest in winter. Initial motility score did not show any marked difference between seasons. pH was slightly higher in autumn than during the other seasons. Average sperm concentration and total number of spermatozoa per ejaculate, were highest in spring and lowest in autumn. Average percentage of abnormal spermatozoa was highest in winter and lowest in autumn.

Results obtained during this period, which are in agreement with the previous years findings, show that spring was marked with the best quality of semen and autumn the worst.

62. Further observations on seasonal variations in semen, and hæmoglobin and cell-volume contents in the blood of bulls.

As a result of further works it was observed that during autumn and summer the average semen samples were thin milky and during spring and winter, milky. The average initial motility, number of spermatozoa per c. c., total number of spermatozoa per ejaculate, percentage of haemoglobin and cell-volume contents in the blood was highest in autumn. The average percentage of abnormal spermatozoa was highest in winter and lowest in summer. There was no marked difference between seasons in 'reaction time' and pH. of semen.

On the whole the quality of semen as well as blood was observed to be best in spring and worst in autumn which is in agreement with the last year's finding.

63. Further study on seasonal variations in the semen of sheep.

D. D. SHUKLA *and* P. BHATTACHARYYA, Izatnagar.

As a result of further works it was observed that the 'reaction time' was highest in summer and lowest in winter. The average volume of semen produced was comparatively higher during spring and summer than in autumn and winter. Colour and consistency of semen was thick creamy during winter and spring and thin creamy in summer and autumn. Initial motility was somewhat steady throughout the year. A verage pH was slightly higher in autumn than during the rest of the seasons, average concentration of spermatozoa was highest in spring and lowest in autumn. The average total number of spermatozoa per ejaculate was at high level during spring and winter and markedly low in autumn. Percentage of abnormal spermatozoa reached the peak in winter; there did not exist any wide variation in this characteristics during the other seasons.

In confirmation of the results obtained last year, it was observed that majority of the semen attributes under study were at their best in spring and worst in autumn.

64. Further observations on augmentation of fertility in cows and she-buffaloes by PMS.

S. N. LUKTUKE *and* P. BHATTACHARYYA, Izatnagar.

Attempts have been made to induce oestus and ovulation in 36 animals consisting of 19 buffaloes, 10 cows, 4 buffalo-heifers and 3 heifers and the results obtained have

been presented in this paper. These animals had not shown any symptoms of heat for more than four months since the last calving and at the time of treatment were found to have anoestrus ovaries excepting in one cow where a persistent corpus luteum was ordinary present. In 14 animals, the PMS prepared in our laboratory was used; in the remaining ones two proprietary preparations, Antostab and Gestyl were tried. The route of administration was either subcutaneous or intramuscular and the dosage varied between 1000 i.u—2000 i.u.

Out of 36 animals, 5 cows and 12 buffaloes were slaughtered 4-26 days after injection. All the animals except one cow and two buffaloes exhibited clear signs of heat 3-9 days after injection. Ovulation occurred in 4 cows and 8 buffaloes. Twin ovulations had occurred in one cow and one buffalo. Both the ova were recovered from fallopian tube washings in case of the cow, and only one ovum in case of the buffalo. The ovum was also recovered from the fallopian tube of another buffalo.

65. Preliminary report on the field application of Artificial insemination in India.

P. BHATTACHARYYA, Izatnagar.

The report deals with the first 13 months data collected from the 3 artificial insemination centres.

Montgomery, (Punjab).—At this centre a total of 1560 inseminations from 307 collections were performed. The average volume of semen collected per ejaculate was 3.8 c.c. for cow bulls 2.46 c.c. for buffalo bulls and 0.9 c.c. for rams. The average number of animals inseminated from each ejaculum works out to 4.9 for cows, 5.4 for buffaloes and 4.2 for rams. The cow-bulls gave an average over-all fertility of 76.6%; buffalo-bulls 70 7% and rams 85.8%. These figures are more than those obtained through natural service.

Inseminations were performed using both neat and diluted semen of different ages. It was noticed that diluted semen gave as good results as those got from neat semen. Results from preserved semen are available. The fertility obtained was comparable with that got from fresh semen and it varied from 70 to 81%.

Similar observations have been recorded for Patna and Calcutta centres.

In addition the report discusses the various difficulties encountered in practice in the field and how they could be overcome.

THERAPY

66 Vaccination Against Johne's Disease by Premunition.

P. C. NAG, Mukteswar.

The value of vaccination against Johne's disease by premunition in cattle has been well recognised in France but no such work is taken up in this country, where this sad disease is responsible for great economic loss to our livestock. In this article the author describs in detail his method of premunition and ultimate protection of cattle against Johne's disease in France and discusses the possibility of following similar procedure in this country. Experimental observation carried out so far in this country has given encouraging results.

67. Studies on Sterne's anthrax Vaccine.

V. R. RAJAGOPALAN, Mukteswar, Kumaun.

When virulent strains of *B. anthracis* are streaked on 50 per cent serum agar

plates and incubated in an atmosphere of 10 to 30 per cent CO_2, smooth mucoid colonies develop. On further incubation the smooth colonies throw out rough perepheral out growths. This variation from smooth to rough is irreversible and is accompanied by loss of virulence but with retention of immunistng properties. (Sterne, 1937).

Vaccine (spore suspension in 50 per cent glycerine saline) made from such rough variants was potent and safe for use in cattle buffaloes, horses, mules, sheep, goats, camels and elephants.

A dose of 1500 spores confered some immunity in sheep and 30,000 or more spores confered a solid immunity.

If used at a dose of 1 million spores no saponin was required to enhance the immunity.

Solid immunity was established in 6 days after vaccination. The immunity lasted for about 3 months and then it gradually passed off until after one year very little immunity was detectable.

The strength of the vaccine, as judged by the viable count, fell to about 50 per cent in about one fortnight. No further marked deterioration took place over an observation period of one year. The vaccine was potent after a storage of one year and a half at temperatures of 5°C. to 30°C.

68. Studies in Chemotherapy of surra with new drugs.

B. C. Basu, Izatnagar.

Studies in testing the chemotherapeutic value of various drugs against surra were conducted. In every experiment control were kept. Four drugs, namely, Trypersamide, Neoarshphenamide, Neostibol and Paludrine were tested on guinea-pigs infected with *Trypanosoma evansi* with a single dose (intramuscular) of 0.1, 0.04, 0.01 and 0.41 grams respectively per kilo body weight as recommended by Dr. B. Mukerjee.

All these four drugs were found unsuitable as they could not stop the appearance of the trypanosomes in the peripheral circulation of the guinea-pigs nor could they save the animals.

59. Induction of Lactation in the Bovine by Administration of Synthetic Oestrogens.

S. N. Luktuke *and* P. Bhattacharya, Izatnagar.

Attempts have been made to induce lactation in two nulliparous heifers and four dry cows of Hariana breed by subcutaneous implantation of small tablets and injections of Diethylstilboestrol. The heifers were matured but anoestrous and the cows were dry for a period of over two years and repeated inseminations failed to get them into calf. In one case the cow was dried off after the first induced lactation and the treatment was repeated in different dosage level during the second induced lactation. The total dosage varied from 250 mg. to 2000 mg.

No response was obtained in one cow and in another one where the heaviest dosage was tried the tablets had to be removed owing to the formation of abscess. The maximum daily yield varied from 3-11 lbs. and the total yield from 341 lbs.—1333 lbs. during a period of 112-262 days. The best response was obtained with a dry cow which gave a maximum yield of 11 lbs. daily and a total o+ 1333 lbs. in 161 days. This cow had given a maximum daily yield of 8 lbs. and a total yield of 1245 lbs. in 209 days during the first induced lactation and a total yield of 2910 lbs. in 307 days during the preceding normal lactation. No nymphomaniac syndrome was observed.

70. A study of the Bacteriological types of C. diphtheria present in Bombay.

D. W. Somon and S. K. Nail, Bombay.

This work was carried out for a period of nine months. Nearly 500 throat swabs were examined and cultured for the presence of C. diphtheria. 175 strains were isolated, out of which 167 were of the 'mitis' type, 7 of 'gravis' type and 1 belonged to 'intermediate' type. Cultures were done on Loeffler's serum and blood tellurite medium. Out of 127 cultures thus isolated, 93. 7% of the strains could grow on both media, 4% strains only grow on blood tellurite medium and 2.3% of strains on Loeffler's serum slope. On isolation, the morphology, colony appearance, haemolysin production and fermentation of usual subtrates in addition to starch and glycogen were studied to determine the types. Virulence of 40 strains was tested in guinea-pigs by intradermal test and they were found to be virulent. One strain isolated from a cutaneous lesion from a patient was found to be avirulent.

SECTION OF ENGINEERING AND METALLURGY

President: N. Sen, M.MET., B.Sc., F.R.I.C., F.I.M.

1. Effected of Void on the Efficiency of Distillation in a Packed Column.

P. L. Jalota *and* S. K. Nandi, Bangalore.

In a packed distillation Column and in multitubular packed Columns (Selkar, Burk, Lankelma, Ind. Eng. Chem. Anal. Ed. 1940, 352) voids are present because of which some vapour passes without coming in contact with reflux resulting in channelling and decrease in efficiency but the advantage is low pressure drop with low holdup which is important when distillation under high vacuum is concerned. In the present paper some data are reported on the variation of column efficiency due to presence of voids.

A 2¼" I. D. Copper tube was used as the column and the height of the packed section was 3'-7". For the packed column 2/5" diameter copper Lessing rings were used while for the multitubular column, six glass tubes each 43" long and 5/32" I.D. were put in the column, the remaining portions being filled with Lessing rings. The cross-sectional area of the void thus created in the multitubular column was 3% of the area of the column.

The rate of distillation was varied from about 8 cc. to 65 cc. per min. H. E. T. P. in the packed column varied from 8.7 to 10.75 inches for the system methyl alcohol-water, from 4.42 to 6.61 inch for ethyl alcohol-water and from 8.2 to 12.3 inch for Benzene-toluene while the corresponding values of H. E. T. P. in the multitubular columns varied from 8.3 to 11.46, 7.47 to 11.46 and 10.75 to 28.66 for the three systems respectively at different distillation rates. It will be seen that H. E. T. P. increases slightly with vapour velocity in the packed column but very rapidly in the Multitubular packed columns. This is due to the fact that the amount of vapour passing through the long glass tubes without coming into contact with the reflux increases as the vapour velocity is increased resulting in decreased efficiency. Thus the presence of voids in a packed column may not have any appreciable effect at low rates of distillation but the efficiency goes down rapidly as the throughput is increased. Manometers connected at the bottom of the still indicated less pressure drop in the case of multitubular columns than in the case of packed columns.

2. Periodic or Rhythmic Variation of the Intensity of Short Wave Radio Signals.

S. S. Banerjee, G. C. Mukerjee *and* R. N. Singh, Benares.

In a few previous communications (Science & Culture, 11, 571, 1946; Nature, 158, 413, 1946; Proc. Ind. Sc. Cong. 1947, Sec. 3, Abs. No. 45) we have reported the observations made by us on fading of short-wave radio signals received at different hours of the day, and described, with possible explanations, the various patterns of fading obtained on those occasions. It may be mentioned that for reasons of their formation, the patterns of fading have been divided into two main categories of (1) random and (2) periodic types.

The present communication contains the results of detailed study of the periodic or rhythmic types of fading which are generally observed during the sunrise and sunset hours, and their significance for practical radio communication has been indicated. It has been shown by measurement of the angles of arrival of the downcoming waves that such periodic fading may occur due to interference caused by two waves reflected either

from one or two—different layers of the ionosphere, when one or both of them have slow vertical movement, presumably due to rapid change of ionization during the transition period of the layers. It has been further shown that the development of slow periodic fading may be due to the approach of maximum usable frequencies between the transmitting and receiving stations, and on such occasions the interference may be caused by magneto-ionic components of reflected waves as suggested by Appleton and Beynon (Proc. Phys. Soc., 59, 58, 1947). The above interference phenomena have been verified by recording the periodic fading of shortwave signals transmitted from Delhi on 16 to 41-metre bands at various hours of the day during different months.

3. On the underground water resources of Madras.

S. V. GANAPATI *and* O. T. RAGHAVAN, Madras.

Owing to unprecedented drought during the years of 1938 and 1939, the level of water in the only reservoir forming the then existing source of water supply to Madras became alarmingly low and in consequence severe restrictions were placed on the water supply and new sources to augment the old were sought. Two hundred and forty tube-wells, seventy bore wells and three twenty feet diameter wells were installed in the City besides renovating old, dis-used kitchen and garden wells attached to individual houses. The important chemical characteristic (such as the hardness, chloride and total solids) and the bacteriological quality of the three types of underground water resources as well as the hydro-geology of the soil overlying the water-bearing stratum are described.

4. On Double Filtration of an Impounded Surface water in Madras.

O. T. RAGHAVAN *and* S. V. GANAPATI, Madras.

A comparison of the modern methods of purification has been made possible, thanks to the labours of "The Committee on Water and Sewage Purification" appointed by the Madras Government for finding out the best method of purifying the water of the Red Hills Reservoir which has earned a name for itself as being the most difficult to purify satisfactorily. This Committee carried out experiments during 1927 to 1933 similar to those carried out by the late Sir Alexander Houston for the Metropolitan Water Board, London, on "Double Filtration" making use of (a) a rapid sand filter, (b) a coke filter and (c) a gravel sand filter, all receiving unalumed water, the secondary filter in each case being an ordinary slow sand filter. Besides, the Committee carried out experiments where (1) the prefilter was a rapid sand filter receiving either (a) alumed and settled water, or (b) alum and lime treated water followed by ordinary slow sand filtration at the slow (4 inch) or semi-slow (6 or 8 inch) rate, and (2) the prefilter was a percolating non-submerged filter using five different kinds of filter media followed by semi-slow sand filtration in each case.

The authors have compared the mass of analytical data (obtained from the above experiments), which are not readily available to the Water World.

5. Fifty years of public health and water supply practice in Madras.

O. T. RAGHAVAN *and* S. V. GANAPATI, Madras.

Freedom from diseases, abundance of wholesome drinking water available at all hours of the day and night and decent houses to live are sine qua non of *public health* of a village, town or city. The progress made in these directions is known only when one views retrospectively the conditions which existed in the previous decade or half-a-century. An attempt has been made in this paper to make statistical study of the ***Public Health*** of the City of Madras with special reference to its water-borne diseases and to correlate it with the water supply practice during the last fifty years (1897-1946).

6. A critical note on Puri Siltometer.

G. S. RAISINGHANI, P.O. Halani, Sind.

The study of silt charge and silt grade is one of the most important problems of canal engineering and river physics in the light of Lacey's Theory of Regime Flow. A large number of suspended and deposited silt samples is analysed mechanically with a view to assess 'm' value for substitution in the Lacey Formulae to construct Regime Flow Equations. Though the chief difficulty of mechanical analysis of coarse silts and sands was solved by Puri Siltometer on account of its simple and rapid working, some defects in its construction were noticed and some inaccuracies in the results of silt analysis were observed specially with regard to the influence of temperature on the reduced diameter size, effect of the bottom taper and the jerky rotation of the water trough carrying silt collecting cups on the silt size distribution, variation in the results of silt analyses on repetition, the influence of shape of silt particles on their rate of settling velocity, distribution of individual silt fractions in different silt collecting cups on re-analysis. A critical study of Puri Siltometer was undertaken by the writer in the Irrigation Research Laboratory of the Sind Public Works Department and the observations have been reproduced in the present note to illustrate the practical difficulties encountered in the working of Puri Siltometer so that this valuable instrument may be more serviceable in the most important work of silt analysis by suitable modifications, which have been suggested.

The paper is accompanied by Diagrams, Graphs and Statements showing results of Silt Analysis.

7. Output and other relations of Electronic Circuits.

RAMCHANDRA NATARAJAN, New Delhi.

The object of this note is to present the general output relations of electronic circuits from the stand-point of analytical geometry.

It is believed that analysis of electronic circiut with the use of Co-ordinate geometry throws into relief certain properties in the neighbourhood of the maximisation regions, not particularly evident from the corresponding inferences on Maximum from other methods. As the absolute conditions of maximisation hold good in practice only within varying degrees of departure, it is not irrelevant to be able to get picture of the Output characteristics more closely than hitherto attempted.

The analysis of the circuit is thus made to reduce to the study of the characteristics of the apposite conic. Interpretations of results are compared with otherwise known behaviours of such circuits.

It is believed that if a system of analysis is developed for tackling multi-stages circuit such as an amplifier or any communication circuit, it would help design. In this connection it may be pointed out that certain circuits show their conic sections as from a two-stage circuit of equally Murdened signal power as an envelope conic of the fundamental stage of the circuit and the Maximised Output Conic for this assembly is the tangential equation to the Output Conic.

Interpretation is, however, the essential part of this method of analysis.

8. Manufacture of Stainless Steel.

H. SRINIVASA SASTRI, Bhadravati.

Stainless Steels are manufactured in Induction Furnaces when very low carbon grades are required. Recently low carbon grades are also made in Arc Furnaces with Metrodyne control. The shaping of stainless steels of certain specifications is a difficult job. Many of the stainless steels are forged with difficulty into billets and then rolled. All the stainless steel ingots are machined to remove defects. After

machining they are closely inspected for roches and other defects and then despatched for heating for forging or rollings. Some of the steels are difficult to forge or roll and the operations are very carefully conducted. After forging or rolling the billets and slabs are again subjected to close inspection and all defects are removed by grinding and chipping. The billets and slabs are again preheated and transferred to heating furnaces and rolled to finished sections.

The finished sections are tested and subjected to careful inspection after heat treatment and picking. They are inspected after finishing operations and despatched to customers.

9. Nitrogen and Sulphur of Coke and its Composition.

M. P. GUPTA *and* A. T. BHATTACHERJEE, Jamshedpur.

From our studies on the elimination and introduction of nitrogen and sulphur in ordinary cokes and synthetic cokes it appears that:

(1) Nitrogen and sulphur are present specially at lower temperatures in a state of ordinary absorption and are in a state of activation and with the rise of temperature they pass into a state of chemisorption.

(2) The maximum absorption is in the region of 400°-500°C and depends on the concentration of these two elements in the system.

(3) With the rise of temp. above 400-500°C parts of the two elements are gradually eliminated but the major parts pass into a state of chemisorption.

(4) Similar behaviour of coals in the process of carbonisation, suggests that the nitrogen and sulphur compounds present in coals, first decompose into their elementary forms which then attach themselves to the cokes formed in the way as stated above.

(5) Part of S (adsorbed) in coke is removable by metallic sodium.

10. Sludging of Scrubber Oil.

A. T. BHATTACHERJEE *and* M. P. GUPTA, Jamshedpur.

It is a known fact that sludging generally takes place in such cases where straw oil (*i.e.*, higher fractions of petroleum oil consisting mostly of paraffin compounds) is used; the trouble is not so much in evidence where creosote oils are used. The view generally held is that this sludging is the result of the formation of polymerides from the unsaturateds present in the scrubbing oil. How far are the unsaturateds present in the gas responsible for this polymeride formation is not yet definitely known. With the view of ascertaining the cause for this sludging first of all a systematic investigation of the oil has been undertaken. From the investigations so far made it appears that:

(1) The oil used in the scrubbers here contains a fair amount of unsaturateds.

(2) Further quantities of unsaturateds are generated by the breaking up of the constituents of high molecular weights into those of lower molecular weights by cracking even at so low temp. as 120°C.

(3) Both cracking and polymeride formation are responsible for the sludge formation, though the former plays the more important role by contributing solid carbon particles and increasing the amounts of unsaturateds as the process goes on.

11. A note on the Determination of Silica in Fluorspar.

H. P. SAMANIA, Jamshedpur.

The difficulties and sources of error in carrying out by the existing method the determination of silica in Fluorspar containing feldspar and other silicates are indicated.

Suitable modifications to the perchloric-boric acid method of decomposition (Schrenk and Ode, Ind. Eng. Chem., Anal Ed., Vol. I, 201, 1929) in order to make it applicable to this kind of ore have been worked out.

12. Determination of Tin and Rare-Earth Acids in Wolframite.

H. P. SAMANTA, Jamshedpur.

A study has been made of the various methods of determining Tin and rare-earth oxides (Colombium and Tantalum) in Wolframite. A method is proposed for the preliminary separation of tin and rare-earth oxides together from tungsten and subsequent estimation of the elements concerned. Results are found to compare favourably with the existing methods.

13. Investigations on Colorimetric Methois of Metallurgical Analysis.

Part VII—Spot tests for allowing elements in steel—Chromium and Manganese.

G. V. L. N. MURTY. Jamshedpur.

A comparative study of the diphenyl benzidine and the diphenyl carbazide methods for the detection and approximate estimation of chromium in alloy steels has been made and it is shown that the former is less suitable for low chrome steels (5%). Improvements have been effected in the diphenyl carbazide method, making it more elegant by employing the impregnated paper technique. Similar comparative study of the ammonium persulphate and the sodium bismuthate methods has been made for manganese. The sodium bismuthate method has been recommended with some modications. The impregnated paper technique is shown to be suitable only for high manganese steels.

14. Studies on Rural Water Supplies.

K. SUBRAHMANYAN, T. R. BHASKARAN *and* C. CHANDRASEKAR, Calcutta.

Investigations were carried out for a period of 2 years on the quality of water drawn from tube wells and other sources of drinking water used by people in rural West Bengal and on the problems of maintenance of these sources in a satisfactory and safe condition. The investigation was confined to 2 Unions, 16.7 sq. miles in area with a population of about 27,000 using 315 drinking water sources.

The results show that tube wells of moderate depth can serve as satisfactory sources of water supply in rural areas with soil conditions similar to those obtaining in this area *i.e.*, over a large part of the Gangetic plain and delta. These tube wells yield water whose bacteriological purity is little affected by comparatively insanitary conditions on the surface, heavy usage or even by the use of polluted priming water. The soil around the wells gets compacted so as to cut surface contamination the prevailing chance of ground water wetting contaminated under the prevailing conditions of soil and usage. Examination of 3,586 Bacteriological samples from 134 tube wells spread over a period of 2 years show that a bacteriological standard of 10 coliforms per 100 c.c. in 80% samples is practicable. The standard appears to be consistent with absence of gastrointestinal diseases traceable to tube well water. The procedure for imposing these standards for rural tube wells is discussed.

With the cheap type of pitcher pump commonly used for tube wells in India, an efficient maintenance service is required. The data obtained on this aspect of the problem show that a public tube well needs on an average 2 repairs in a year, and that the total cost of maintenance of a tube well is about Rs. 8|- per annum. This money and an organisation for repairs should be provided for by the local authority of Government whenever tube wells are installed in rural areas.

Open shallow wells even when conserved by parapets, steining etc. yield water that is definitely inferior to tube wells in bacteriological quality. Evidence has been adduced to show that the bulk of the pollution introduced into the wells comes through the

top and through buckets and ropes. By covering the well and fitting it with a pump to draw water it is practicable to attain a standard of 100 coliform organisms per 100 c.c. in 75% samples. Data presented show that it is necessary to carry out further work before any bacteriological standard for this type of rural water sources can be determined.

15. Treatment of Starwboard Wastes by Trickling Filter.

K. SUBRAHMANYAN *and* T. R. BHASKARAN, *Calcutta.*

Disposal of wastes from a Strawboard Factory in Bhopal has been one of serious concern to the Public Health authorities of the State. The Factory is producing about 4,00,000 gallons of waste daily with over 2500 p.p.m. total solids of which 65% is organic and about 50% suspended. The pH of the wastes varies from 8.0 to 8.4. Water for dilution of wastes is inadequate in the locality and offensive conditions are produced in the lower reaches of the channel into which the effluent falls.

Various methods of treatment of the wastes have been tried. Addition of chemicals such as alum, iron-salts and sulphuric acid was tried for coagulation of suspended solids. Only sulphuric acid was somewhat effective but the dose required for was 2,000 p.p.m. *i.e.*, 4 to 6 tons of H_2SO_4 per day and this is impracticable. Bubbling of flue gas (which is easily available in the factory) through the wastes at ordinary room temperature was tried, but this did not prove useful.

An experimental trickling filter $2' \times 2' \times 6'$ has been designed to determine whether the wastes could be handled by trickling filter treatment. The design provides for primary as well as secondary settling and for controlled and continuous dosing of filter with the wastes directly as it flows out of the factory. Filtering at a rate of 3 m.g.a.d. it has been possible to remove over 70% of the organic load in the wastes.

16. Prospects of sheet Metal Industries in India.

J. N. BASU, Calcutta.

Sheet metal industries in India are still in its infancy in India. During the last war certain impetus was given to this industry and it is expected that advancement already made, should be progressively maintained & continued in post war period as well.

In this article I attempted to incorporate the utility, present position, difficulties and schemes of equipments required for the following sheet metal industries.

(1) Metal box (container)

(2) Hurricane lantern.

(3) Torch lights.

(4) Metal toys.

(5) Hinges.

(6) Stampings for electric motors, transformers & other electric equipments.

Each of these industries has a vast field in India; the articles made therein are extensive used now a days & some of them fortunately are already receiving favourable consideration by the Govt. of India with certain facilities for their advancement.

The fundamental difficulties common to all sheet works in India lie in the following:—

(1) Steel for the die or tool,

(2) Die making;

(3) The presses & other metal working machineries.

(4) The quality of sheet for stamping.

The special steel that is required for tools or dies, is not made here. During the war Tata attempted to produce a limited quantity of die-steel. But practically we have

to depend on foreign imports for these articles. Often the steel dealers make the position still more complicated and insecure, being not in a position to supply correct specifications of the steel. There have been very often cases of disappointment, when steel that was purchased for making dies was subsequently found quite unsuitable for the purpose, sometimes after wasting money, time and labour over it by making dies out of the steel. Die is an expensive and accurate tool and unless made of properly selected special steel, it will not last long, nor the work will be accurate.

Die-making is a specialised job; it requires accurate workmanship correct to several thousands of an inch; it requires certain special machines and precision machines and measuring instruments. Besides, heat treatment of dies is another specialised job entailing special furnace with delicate instruments and experienced men to handle it. In India we have at present no specialised die making firms, consequently sheet metal workers are forced to start die-section for their works; that is firstly very expensive requiring substantial capital investment and secondly cannot be so efficiently and economically run. It is definitely a big handicap for maney sheet metal works requiring simpler dies or small number of dies for their production; so to advance sheet metal works, die-making should be promoted.

Presses and other sheets metal working machineries. The following are very commonly required in sheet metal work:—

(1) Presses:—(*a*) Power press, (*b*) Fly ball press; (*c*) Hydraulic press.

(2) Gullotine or shear machine;

(3) Rolling machines; (4) Bending machines (5) Circle cutting machine; (6) Folding machines; (7) Beading machines; (8) Seaming machines;

Power presses are specified by the maximum pressure the press can safely exert when working and are known as 20 ton press or 20 ton capacity press. They are either (*a*) Open fronted or C—frame or (*b*) double-sided, having two column on 2 sides of the press. Another important classification of the presses is (1) Single-action; (2) double & (3) triple-action; they widely differ in design, construction & operation.

The pressure for blanking is determined by the equation $P = L.\ T.\ S.$, where P—Pressure in ton. L—length of cut in inches $= \pi$ D in case a blank of D inches diameter is punched.

T—thickless of metal in inches and S—shearing stress of metal in tons per square inch. The pressure for stamping is still a matter of experience and no definite equation can be found out as yet.

The presses are sometimes stated to have capacity proportional to (*a*) Weight of the fly-wheel, or (*b*) Weight of the press itself or (*c*) diameter of the crank-pin; but these equations could not be completely relied on.

Selection of the right press is governed by such factors as:—

(*a*) the size & type of die required.

(*b*) the length of stroke necessary.

(*c*) pressure required for doing the work.

(*d*) distance above the bottom of the stroke where the pressure first occurs.

(*e*) Additional pressure required due to attachments such as are used for drawing work.

(*f*) The method of feeding, the direction for feed, the size of sheet blank, or article.

Only single action power presses up to 30 ton are manufactured in India. Double-action or triple-action and of higher capacity presses are imported. Fly-ball presses of

various capacities, hydraulic presses of limited quantities are also made here now-a-days. Beside, the following machines are also manufactured in India since the last world war to some extent:—Gullotine, Rolling, Bending, Circle-cutting, Folding, Beading & seaming which were usually imported from foreign countries before the last war.

The sheet for blank:— ordinary black sheet or bright-finish or P. C. R. C. A. (pickled cold—rolled, close—annealed) as required for hinges, toys, torch etc. and limited, quantity of tinned sheets, that are required for food canning and hurricane lantern, are made here in India. The stalloy sheet that is needed for electric motor A. C., transformers and other electric apparatus, are not manufactured here. We have to depend on foreign import for this article. This is a great handicap for the manufacture of these equipments in India; inspite of the fact that the Govt. of India have prevented the import of certain types of motors and transformers, still the industry is not duly promoted.

The qualities of sheet, such as uniformity in thickness, ductility & finish, besides composition are important factors to obtain good and smooth pressings, free from defects.

In conclusion, I state below two schemes containing list of equipments needed for;

(1) Metal box manufacture

(2) Hurricane Lanterns

Equipments for Metal box manufacture:—

(1) Shearing machines:—

(*a*) Hand shear, (*b*) Power shear, (*c*) Circle cutting.

(2) Presses:—

(*a*) Ball presses-6 of different sizes (*b*) Power presses—8 of different capacities.

(3) Seaming machine:—

(*a*) Circular, (*b*) Elliptical, (*c*) Rectangular;

(4) Folding Machine: (5) Beading machine: (6) Printing equipment: (7) Soldering equipment: (8) Welding set: (9) Electroplating equipments (10) Spray-painting equipments. (11) Stove enamelling arrangements: (12) For die-making:—Lathe, Drill, Milling, Shaping, Planing, Grinding, Do-all, Power-saw, welding.

Item 6, printing equipments to print on sheet is a complicated job and the equipments are also very expensive. We are to depend solely on foreign import for the machine which is very costly as well.

Equipments for Hurricane Lantern factory:—

(1) Shearing machines.—(*a*) Hand-2 pcs: (2) Power-2 pcs; (3) Circle cutting-1 one.

(2) Power presses of different capacities from 10 tons to 40 tons both single action & double action-30 pcs.

(c) Ball—presses & arbon presses-24 pcs.

(4) Seaming machine-6 pcs.

(5) Folding machine-2 pcs.

(6) Bending machine-2 pcs.

(7) Soldering equipments.

(8) Electroplating arrangements.

(9) Spray-painting equipments. (10) Stove enamelling equipments.

(11) For die making.—Lathe, Shaping, Milling, Grinding, Drill, Power-saw, Do-all, Welding set.

The complete set of equipments will cost nearly Rs. 200,000/- (two lacs) and can produce about 400.000 lanterns each year. The working cost is calculated to be Rs. 1|4|- per lantern.

17. The Spectro-chemical Analysis of Ferrous Alloys with the Medium Quartz Spectrograph.

K. C. MAZUMDER, Jamshedpur.

A preliminary report is given of the Spectro-chemical determination of the elements Al, W, V, Mo, Ni, Cr, Cu, Mn and Si found in the ferrous alloys by means of the medium spectrograph. This instrument is not considered to be good enough for this work on account of its low dispersion. The calibration curve obtained for the above elements are given. The curves are regular and smooth showing that the instrument can possibly be used for carrying out the ferrous alloys analysis.

18. Calibration of Photographic Plates.

B. N. BHADURI, Jamshedpur.

A series of experiments for purposes of plate calibration is intended to be carried out. The first of the series follows and an account of the method for selecting the appropriate calibration line pairs is given. Analyses of high speed steel by spectrographic methods were carried out in the research laboratories of the Works. Plate calibration from intensity considerations alone, and its application for evaluating alloys in steel were thought desirable. The first object was thus the selection of line pairs.

19. The Spectro-Chemical Analysis of the Bearing Alloys.

M. K. GHOSH, Jamshedpur.

The technique of spectro-chemical analysis of the bearing alloys with copper base has been developed by means of Hilger Medium Quartz Spectrograph. The ranges of the different elements determined are:

Sn	6.50-7.90%
Pb	3.0 -3.65%
Ni	0.70-1.0 %

The determinations agree well with those found chemically.

20. Basic-to-neutral Refractories from Refractory and Non-Refractory Magnesium Silicate Rocks.

H. K. MITRA, Jamshedpur.

Practically neutral refractories have been developed from refractory and non-refractory Magnesium Silicate Rocks. Following the line of investigation, for making refractories from non-refractory Chrome Ore as described in a previous paper the raw materials were calcined to about Orton Cone 31 with the addition of Magnesium Carbonate to form Forsterite and Spinels. To further improve the Slag Resistance of the resultant brick Chrome Spinels were formed by introducing High Grade Chrome Ore at the time of Calcination. The method described makes it possible to utilise a variety of raw materials including non-refractory ones, for the manufacture of refractories with superior physical properties.

21. Petrographic Data on Chrome Magnesite and Magnesium Silicate Refractories.

J. C. BANERJEE, Jamshedpur.

Petrographic properties of Indian Silica and Magnesite bricks have been reported in a previous paper. In the present one Petrographic Data on Chrome Magnesite and Magnesium Silicate Refractories have been given. For comparison European and American Bricks have been included. An attempt has been made to interpret the Refractoriness Underload Values in the light of their Microscopic Characteristic.

22. Coking Properties of Coal.

S. N. SIRCAR, Jamshedpur.

In view of the limited reserves of coking coal in India which is indispensable for the Iron & Steel Industry, measures have been taken to restrict its use for metallurgical purposes and to blend with inferior grade poorly coking coal with a view to prolonging its availability for metallurgical purposes. Even then because of the contemplated industrial expansion in the country the period of this availability cannot be so prolonged as to safeguard the existence of the metallurgical industry in India for long. The only possible means of enlarging the coking coal for the metallurgical industry is to explore the possibility of converting the non-coking coals into coking coals.

These can be done only by intensive research on the coking properties of coal.

Prof. Wheeler, Frank, Fisher, Parr, Hadley and many other research workers have carried out research with a view of studying the fundamental structure of coal by extraction method.

Blayden, Riley and Show made X'ray studies of coking coal for determining agglutinating properties. Work has also been done to produce coke from non-caking coals by various means. Fisher experimented on the carbonisation of coal under a pressure of about 50 atmos and he obtained strong dense coke from non-caking coals of high Oxygen content. L. J. Davis has described the production of coke from powdered anthracite by mixing it with 20% of pitch or 25% of tar. Bergins process of hydrogenation of coal by hydrogen under pressure also improved the non-caking coal of which the caking power was even beyond the range of normal coals.

Besides the academic work mentioned above many attempts have been made for practical use of the processes developed though none has been reported to be of any commercial importance. Some of these processes are: the 'Fuelite' process of England, the 'Carbocoal' process of America, 'Colloidal Briquetting' and 'National Fuel Process' developed by the American Cyanamid Co. of America and lastly the 'Two Step' process of converting non-caking coal into coke as developed in Germany.

In the interest of the metallurgical industry in India coking research should therefore be given the first priority and some of the processes described above or new process developed and made into a commercial success.

23. Planning of Consumption of Coal (Scientific and Rational Use).

A. K. SHAHA, Calcutta.

The principles on which the Planning of Consumption of Coal will be based, may be taken as the following:—

1. The Attainment of complete combustion of coal with minimum excess air wherever coal is used as Fuel.
2. The Utilization of all the amount of Heat thus developed for useful purposes, with minimum loss.

3. The complete Recovery of By-products during the process of Carbonization of coal.

4. The use of Proper grades of coal to suitable Industries. If these four Scientific Principles are adopted, the present consumption of coal can be reduced by 20-25 p.c. and in 1956, the production of 32 million tons of coal will serve the need in place of 41 million tons, as proposed by the Coal-Fields Committee, 1946.

A simultaneous campaign on two Fronts Production and Consumption can solve our National Problem. The demand for unscientific and irrational consumption should not be met by increase of Production as this would mean waste of National Wealth.

The scheme is based on present conditions with minimum additions and alterations and without slightest interference with the routine work of the plants. Of course Scientific measures always go parallel with the increase of Production as well as better quality of Products.

The following examples of huge misuse of coal and their remedy explained:—

1. Loss of 30 million gallons of tar in the process of soft coke manufacture is increased every year. The author explains his own method of Low and Medium temp. of carbonization of coal.

2. While operating coal mines—valuable coking coal and as well as 1st grade coal is used in boilers. Author suggests to use dust coal in the form of Briquettes.

3. Railways can use Low grade coal dust formed into enriched Briquettes and as well as to provide modern Locomotives with condenser installation.

4. In boilers, Furnaces and Kilns—to install Recuperators and regenerators.

24. Laboratory Experiments on the Isolation of Ceria from Monazite Sands of Travancore.

V. G. Iyer *and* R. Prasad, Benares.

With the increasing applications of cerium in varied industries, the process of extracting ceria from Monazite sand of Travancore has to be perfected first. An attempt has been made to that effect in this paper. It has been broadly divided under two heads:

(*i*) Introduction and (*ii*) Experimental part.

In the introduction, a brief survey of the deposit of Monazite sands of Travancore has been made with a short historical review on general. Its growing importance has been emphasised owing to its Thorium content which can be used in future as a target atom for the liberation of atomic energy. Apart from its use in the gas mantle industry, it finds application in the manufacture of pyrophoric alloys and various other industries, a fact which has made it still more important.

The experimental part consists of the following:

(*i*) Treatment of crude ore monazite sands.

(*ii*) Qualitative chemical analysis of monazite sand.

(*iii*) Extraction of ceria from Monazite sand.

25. A note on High Frequency Current Density in a Hollow Cylindrical Conductor.

SANTI RAM MUKERJEE, Benares.

Hollow Cylindrical conductors have lately gained very wide application in Radio Engineering. Due to their non-radiating properties, they are conveniently used in connection with ultra-short and micro-wave transmission lines, wave-guides, etc., particularly for Radar and Relevision purposes. It is often found necessary to know the current density along the radius of such a conductor, specially to detect the formation of stationary waves along the cross-section of the tube. The current density for steady sinusoidal current can be calculated by Bessel functions, and in the present communication, the solution has been obtained for varying high frequency current flowing through the conductor. For the purpose of relaxed oscillations, a solution has also been obtained for linear variation of current with time.

26. Some Observations on the Recrystallisation of Silicon Ferrite.

S. VISWANATHAN *and* R. MUTHUSWAMY, Jamshedpur.

The effect of deformation on recrystallisation of one per cent. silicon ferrite has been studied. Increasing deformation increases the rate of re-crystallisation as a resultant increase in both the rates of nucleation and growth.

The effect of temperature on isothermal recrystallisation curves was studied. Temperature increases both the rates of nucleation and growth.

K. C. MAZUMDER, Jamshedpur.

The Binary alloys of some metals like Cu, Ag and Au can be expressed by approximately definite chemical formula and are known as abnormal valency intermetallic compounds. The different phases of these alloy systems have definite electron-atom ratios which are generally expressed as 1.4, 3/2, 21/13 and 7/4 for the α β γ and ϵ phases respectively. They can, however, be expressed more uniformly as 21|15, 21/14, 21/13, and 21/12. This regularity suggests the possibility of extending the series inside the L- phases. The L-phase may, then, be composed of several minor phases of electron-atom ratios, 21/16, 21/17, 21/18, 21/19, 21/20, at the boundaries of which there will be discontinuities, however small, of some physical properties of the alloys. The indications of such discontinuities found in the published data are discussed.

SECTION OF AGRICULTURAL SCIENCES

PRESIDENT: RAI BAHADUR KALIDAS SAWHNEY, M.SC., F.A.SC.

1. Effectiveness of Green Manuring in Terms of Crop Production.

P. G. KRISHNA *and* D. V. G. KRISHNAMURTY, Hyderabad-Deccan.

The green matter ploughed into the soil in the form of Sannhemp and Daincha varied from 6,000 to 23,000 lbs. The total nitrogen added to the soil due to both green matter and fixation in soil varied from 160 to 290 lbs. In spite of these huge amounts of nitrogen derived from green manuring, the net gain, as reflected in the yields of sugarcane, is the same as would be obtained from an application of a mere 50 lbs. of nitrogen in the form of oil cakes.

2. Anthocyanic Purple Pigment in the Sorghum Ovary and its Genetic Relations.

C. VIJAYARAGHAVAN *and* A. KUNHIKORAN NAMBIAR, Coimbatore.

Anthocyanic plant pigments occur in several parts of the Sorghum plant. A transient type of purple colour was observed in the ovary of a type of *Sorghum caudatum* Stapf received from Africa. The purple pigment occurred in the sub-epidermal layer of the pericarp of the ovary and was confined to one or two layers of cells only. It was intense at the time of flowering, but faded away in a day or two. The pigment was soluble in water and alcohol and turned into greenish yellow by alkali and red by acids. A survey of the existing types of sorghum at the Millet Breeding Station showed that this character was rare especially in the Indian types. In segregations, the purple ovary was dominant to the colourless one. A factor Po produces this purple pigment in the ovary. Po is a monogenic dominant to po. This gene Po is located in the same linkage group in which sheath—dry anther colour, sheath—juiciness of stem, and sheath—grain colour genes are situated.

3. Influence of Panicle shape on the Vegetative Characters in Ragi—*Eleusine coracana* Gaertn.

C. VIJAYARAGHAVAN *and* U. ACHYUTHA WARIAR, Coimbatore

By grouping the *ragi* population into the phenotypes "top-curved", "in-curved" and "fist-like" and viewing their behaviour critically over a number of seasons, it was observed that the genes E1 and E2 acting additively differenciate the three types in finger length. They also exert an influence on certain other characters like height, length of peduncle and flag length. This multiple effect of the genes was confirmed by a detailed study of comparable sister families. The manifestation of this genic influence was noticeable in spite of the climate factors of different seasons and years.

4. Determination of Milk Solids.

K. M. MEHTA, Jodhpur

In the course of examination of milk samples, cow and buffalo, under the Marwar

Pure Food Act it has been noticed that the total solids of milk generally are in excess by the Richmond scale when compared to the direct Gravimetric method. This is more so when milk is adulterated by adding water, abstracting fat or both. In order that uniform results for total solids in milk are obtained from the different laboratories it is desirable that a common standardised method for its determination is prescribed by the Central Committee for Food.

5. The Ferrous Iron Contents of Indian Soils.

U. P. Basu *and* S. C. Chaudhury, Baranagar, Calcutta.

The deficiency of iron intake leads to nutritional and hypochronic anaemias in man with consequent loss of health and economic efficiency. We get our normal requirement of iron from food stuffs, the major part of which is derived from vegetable sources. The iron contents of these food materials of plant origin are again obtained from the soil on which the plants are grown. As such a knowledge of both the total and ferrous iron contents of a soil would be a valuable guide to the level of iron contents of food crops and other vegetable matter grown on it. It is known (Kliman, Soil Sci. Soc. Amer Proc., 1937, 2, 385) that it is the ferrous iron that is absorbed and utilised by plants.

In this paper total and ferrous iron contents of soils from Bombay, U.P., C.P., Madras, Orissa, Bengal, Bihar, Punjab and Sind have been ascertained, and suggestions have been put forward that the total and ferrous iron contents in various parts of our country and in different seasons be determined. These would be helpful in correlating the relationship between the iron contents of food crops and the health of the human as well as cattle population of the respective areas.

6. An Improved Type of End-Over-End Shaking Machine.

G. S. Raisinghani, Halani, (Sind.)

A large number of soils and sub-soils has to be tested for their total salt content in the irrigation Research Laboratory of the Sind Public Works Department. Actual measurement of electrical conductivity takes far less time than the preparation and shaking of soil suspensions. With the available convenient models of shaking machines, ten soil suspensions could be shaken at a time. There has, therefore, been need of a machine which can shake a large number of soil suspensions at a time without being bulky, costly or unwieldy. With this object the improved type of end-over-end shaking machine has been designed. It is a modification of the Wagner's End-over-end Shaker of the Baird Tatlock and Co., Ltd., London and its advantages are:

(*a*) The convenient size and the principle of end-over-end shaking of the Wagner's Shaker have been retained;

(*b*) The capacity of shaking bottles has been increased from ten to twenty four;

(*c*) For the same cost, construction of the improved Shaking Machine is more robust;

(*d*) More efficient and easy screw device for fastening bottles in the machine has been provided;

(*e*) The improved type of Shaking Machine can carry and shake bottles of any size and shape.

The improved type of Shaking Machine was manufactured in the Kotri Workshop of the Development and Research Division and is now in use in the Irrigation Research Laboratory at Karachi.

The paper is accompanied by a blue print sketch of the improved type of shaking machine.

7. The Influence of Stage of Growth on the Chemical Composition of Some Perennial Grasses.

B. M. PATEL, Anand.

It would be a national economy if fodder crops could be harvested at a stage when they are most nutritive. In order to find out at which stage the three perennial grasses (Napier, Guinea and Eleplant) should be harvested this experiment was carried out.

Three above-mentioned grasses were harvested at the following stages:—

I. (1) Preshooting stage, (2) Boot stage, (3) Infloresence stage, (4) Post blooming stage, (5) Mature stage.

II. Cutting at an interval of 30, 50 and 70 days.

The samples were analysed for their composition which indicates that it is always beneficial to harvest the grasses either at its pre-shooting stage or at 30 days intervals. In the more mature stages the protein, fat and carbohydrate contents are reduced and fibrous portion and silica content portion increased.

8. Structure in Black Cotton Soils of the Nizamsagar Project Area—Hyderabad State.

P. G. KRISHNA *and* S. PERUMA, Hyderabad—Deccan.

The black soils exhibit a characteristic structure in their subsoil. Details of this structure have been noted in the Raichur District in the year 1931. Later on, a special study has been made from about 1943 in the Nizamsagar Project area.

This structure has been termed 'Lentil' as there is close resemblance to the lentil seed.

The shape, size, and make up of the structural aggregates do not fit them into any of the forms—Cubic or Sphere-like, Columnar or Prismatic, and Platy, which are commonly recognized.

Only the upper surface of the aggregate is convex-shaped, when the structure is faintly developed. Both sides of the aggregate are convex when the structure is well developed. The aggregates are quite lentil shaped, stable, and measure (7″ × 4″), (8″ × 5″), (9″ × 5″). They can be detached with ease from the soil body. In soils with impeded drainage these lentils are hard and break into irregular or prismatic clods. In good pervious soils they are soft and peel off into several similar very small stable lentils measuring one by one-fourth inch.

The lentil aggregates are seen to form parts of larger and huge lentils of similar shape, several feet in length and width fitting in with the depth of this structural horizon.

The structural pattern consists of a set of parallel planes of cleavage inclined about 30° to the ground level. These planes seem to indicate the direction of subsoil drainage.

Soils possessing this characteristic lentil structure are highly productive, highly absorptive and not easily erodible. Also, in them, alkaline patches are few and rare.

9. Barbada and its usefulness as Green Manure Crop.

P. G. KRISHNA, Hyderabad—Deccan.

Barbada (*Indigofera barbara* Gamble), a busy leguminous plant of the Indigofera group is found growing wild all over Hyderabad State. This plant was tested for it usefulness as a green manure plant for three years in pots and one year in the field. In pot culture tests extending over three years the plant was found to fix appreciable amounts of nitrogen. In the third year this plant was tested against Sannhemp and

Daincha both for the green matter produced under field conditions and for its nitrogen fixation in the soil. With regard to weight of the green matter (stems and leaves) it was found to be about equal to Daincha and somewhat less than Sannhemp, and the nitrogen added to the soil by ploughing in the whole plant was estimated to be more than that of Daincha but less than Sannhemp, and this was calculated as 60, 55, and 78 lbs. nitrogen per acre for Barbada, Daincha and Sannhemp respectively. By the analysis of soil samples collected before and after cultivation of the crop it is estimated that the nitrogen increase in the soil was about 276, 292 and 256 lbs. per acre for the three crops Barbada, Daincha and Sannhemp respectively. Therefore, Barbada can be said to be quite as suitable as Daincha and Sannhemp for green manuring. Barbada stems are very thin as compared to those of Daincha and Sannhemp and are likely to be decomposed readily in the soil.

Barbada crop is not eaten by cattle, goats and sheep and being a perennial, would be very useful for reclaiming eroded lands and for improving forest soils. Dr. D. V. Shuhart, the American Soil Conservation expert with whom these results were discussed during his recent visit to Hyderabad agreed to its usefulness for green manuring and for soil conservation.

10. Investigation on the Alkalinity and Saltishness in Gur made from Coimbatore Sugarcane Varieties.

P. G. Krishna, Hyderabad—Deccan.

Coimbatore sugarcane varieties when cultivated in new areas yield gur high in alkalinity in ash directly depending upon the water soluble salts in the soils and irrigation waters which are absorbed by the plants.

The alkalinity in ash is lower in gur made from ratoon sugarcanes than in gur from plant (new crop) canes. Also a great number of gur samples from ratoon canes is sweet or less saltish than from new crop This indicates that on continued cane cultivation, the gur produced will tend to be less alkaline and less saltish to taste. In other words, it tends to become sweet.

Sweet gur was always yielded by Coimbatore Sugarcane variety 419, and almost always by 434. On the other hand, Co. 290, 301 and 244 always gave saltish gur. This may be varietal characteristic indicating selective absorption of the salt present in the soil.

There was no correlation between the taste of gur and total alkalinity in its ash. Some gur samples with high alkalinity had a sweet taste while others with very low alkalinity had saltish taste.

Saltishness in gur is due to the presence of chloride in it If the chlorine content is more than 0.50%, the gur tastes saltish The sulphate content has no such effect.

For new irrigated areas, it is suggested that a variety of sugarcane like Co. 419 which always yields sweet gur may be grown In the alternative, prior to the introduction of Coimbatore sugarcane varieties, ryots may be advised to cultivate paddy for at least two seasons before planting cane so that the chances of obtaining saltish gur become minimised.

For reclaiming saline areas Co. 290, a very hardy variety, may be recommended to be cultivated, along with systematic leaching, as this variety not only absorbs large amounts of salts but also withstands water-logging.

11. Studies on Indigenous Methods of Storage of Butter.

K. S. Rangappa *and* B. N. Banerjee, Bangalore.

Desi butter is stored for a number of days before it is melted into ghee. In some villages it is stored over buttermilk but generally in collecting centres and with retailers

or wholesale dealers it is stored dry in tins. An examination of the two methods showed that after 12 days of storage, the sample in butter-milk of 0.6-0.8% acidity developed six times less (0.56%) acidity than that stored dry (3.4%). Experiments on storage of butter in water and in lactic acid solution (0.8%) showed that while storage in water largely suppressed acidity development, the butter tended to lose flavour. In lactic acid, on the other hand, the flavour also was retained. From the point of view of flavour, low acidity and storage property of butter and ghee, storage in the following order, in lactic acid solution, butter-milk or water is recommended The liquids should be changed every day. However, butter should not be stored in hot climates at all, but melted into ghee at once as even salted, pasteurised and tinned creamery butter (Indian or Australia) do not keep sweet for more than four months (% acidity).

12. Standardization of the Ginning Technique for Small Samples.

R. L. N. Iyenger *and* D. L. Sen, Matunga (Bombay).

The object of the present investigation is to standardize a technique for ginning small samples of cotton in cotton breeding stations which would give the value of the ginning percentage corresponding to that given by a normal commercial gin. The study was carried out to find the effect on the ginning percentage of three factors, namely, (1) the size of the sample, (2) the method of selecting the sample and (3) the gin used for ginning.

In connection with the first factor different weights of *kapas* were ginned in the same gin but the results did not show any significant influence of the weight of the sample on the value of the ginning percentage.

On the other hand the second factor was found to produce a significant change. A sample made up of whole locks or lumps of *kapas* gave a significantly higher ginning percentage than a sample made up of separated single seeds.

With regard to the third factor tests were made on five kinds of roller gins, *viz.*, (1) locally made wooden gin from Parbhani, (2) Bardoli gin, (3) table model gin, (4) Platts hand gin and (5) Platts power gin of the commercial type. The last three gins were of the Macarthy type while the first two were made of a combination of two rollers The results obtained showed that on the whole the first two gins *viz.*, Parbhani and Bardoli gins gave a value of the ginning percentage which was about four to five per cent. higher than the values given by the other three gins, the differences among which were only very small. This increase in ginning percentage was found to be due to the crushing of some seeds which were carried over along with the lint. The time taken from ginning a specified quantity of *kapas* was also very much higher in the case of the former two gins as compared with the latter. However, the lint obtained from the former gins was slightly longer and more regular than that obtained from the latter gins.

From the above findings it can be concluded that on account of the higher value of the ginning percentage given by Parbhani and Bardoli gins and on account of the longer time taken to gin in these gins, they are not suitable for standard ginning practice. On the other hand Platts hand gin takes only a small time for ginning and it has the elasticity of managing different sizes of small samples usually met with in cotton breeding as far as possible, all foreign matter that may be present in it.
work. Furthermore it gives the value of ginning percentage which corresponds to that given by the commercial gin and therefore, it can be recommended for general use. For standard ginning practice 25 gm. sample, made up of either whole locks or of lumps of *kapas* appears to be a suitable quantity. It is, however, essential that before the *kapas* is weighed for ginning, it should be thoroughly opened out by hand so as to remove,

13. Compost from Town Wastes, its Composition and Effect on Crops.

K. G. JOSHI *and* P. S. THAKUR, Nagpur.

The Bangalore technique of composting town refuse not only affords a very sanitary method of disposal of dangerous town wastes but also ensures conservation of manurial ingredients in these wastes and their productive utilization as manure.

2. In comparison with good samples of Farm Yard manure, town composts do not show much superiority on nitrogen basis. They show, however, a very high content of total and available phosphorous, about 2—3 times than that of cattle manure and are superior to the latter in this respect. Compared to the low type of cattle manure, the town composts are very rich On an average town composts contain 0.8 to 1.0 p.c Nitrogen and 0.9 to 1.2 p.c. phosphorial Plutoxu. The manure of bigger towns (population above 25,000), is generally poorer than smaller towns, the common drawback in the former being the high proportion of stones and scraps in them.

3. On cultivators fields the data collected by us show that the yields of food crops increase by 50 to 100 p.c. over that of unmanured fields. The manure depicts its bulky nature by showing a residual effect. Certain field experiments also have shown that the manure shows a better performance than the cattle manure but does not compare so favourably with ground nut cake on equal nitrogen basis, as nitrogen of town compost is made available to the plants slowly.

14. Effect of Sunning and Chemical Treatment in Relation to storage of Jute Seeds.

T. GHOSH, B. C. KUNDU *and* N. BASAK, Dacca.

Corchorus capsularis and *C. olitorius* are two common cultivated species of jute. Both of them suffer from 'Stem-rot' disease caused by a fungal pathogen *Macrophomina Phaseoli* (Maubl). Stem-rot is primarily a seed-borne disease The fungus attacks the pod and thereby the ovule and the seed; later the fungus passes into sclerotial stage on and within the seed-coat. It is a common experience that jute seeds cannot be stored in healthy condition for a long period. One of the chief causes is this (1) fungal attack. Other causes are (2) retention of high percentage of moisture on account of improper sunning, (3) premature seed collection and (4) insect attack. Causes (1) and (2) seem to be highly linked. It is seen that after harvest seeds contain as high a moisture percentage as 21.38. Proper sunning at least for 120 hours brings the percentage down to 2.8 on average, which is safe for storage. The best remedy for the primary infection is dry seed treatment with commercial dusts like Agrosan-G or Granosan Hence, sunning followed by treatment with the said chemicals is recommended before storage. Storage is best under dry air tight conditions. The procedure of storage as recommended involves a very low cost and is within the means of the poorest cultivator.

15. A Comparative Study of the Intra-Class Correlation in Relation to the Efficiency Sampling Techniques on Rice.

P. S. SREENIVASAN *and* K. DASARADHARAMA RAO, Poona.

The paper discusses the relative efficiency of the two sampling techniques tried on rice at Karjat. The sampling unit that was tried in the year 1937 consisted of four pairs of adjacent bunches separated by three bunches as shown below.

$$\text{0 0} \underbrace{\text{x x x}}_{\text{omit}} \text{0 0} \underbrace{\text{x x x}}_{\text{omit}} \text{0 0} \underbrace{\text{x x x}}_{\text{omit}} \text{0 0}$$

In the year 1943 the sampling unit consisted of six bunches three each from two adjacent rows as follows:

```
 omit      omit      omit
0 x x x 0  x x x 0    x x

, x x  0 x x x 0  x x x 0
 omit     omit     omit
```

Observations were taken on bunches indicated as "O".

The intra-class correlations for the weekly observations on number of culms per bunch and height are worked out. It was found that so far as the number of culms is concerned both the sampling techniques are quite satisfactory, but for estimating the height the modified sampling technique is more suitable. Also there is a strong indication that the seedlings from the nursery at the time of transplantation have highly variable height. But this initial variation in height disappears a month after transplantation.

16. Microclimatic Survey of a Sugarcane Field.

K. M. Gadre, Poona.

The detailed micro-climatic survey of a sugarcane crop has been made at different stages of growth of the crop. This is done with the help of a large number of observers each equipped with an Assmann Psychrometer for recording the variations of the dry and wet bulb temperatures, as well as the vapour pressure and relative humidity at different places in the field. The variations with height as well as the location within the crop are studied. Diagrams showing at a glance the distribution of air temperature and the vapour pressure within the crop have been prepared. These show that the 'Macro' climate changes into the characteristic 'micro' climate of the crop within a few feet as one enters the crop.

As has been shown by Ramdas in a recent paper [Ramdas, L.A., "The Microclimate of Plant Communities", 1946, The Indian Ecologist, 1(1) : 1] the sugarcane crop developes an effective canopy towards the end of the season when the crop is 15 to 18 feet high, and when this stage of growth is reached, the microclimate shows the maximum deviation from that of the surrounding open space, and there is a pronounced temperature inversion during day time. This day time inversion has been designated by Ramdas as a 'forced inversion'.

The figures also show clearly how big a sugarcane plot ought to be in order to develop and retain its characteristic microclimate. Further studies are in progress.

17. Study of the Progress of Rainfall and Crops week by week, during the year, in India.

A. K. Mallik *and* T. S. Govindaswamy, Poona.

Charts, one for each year, have been prepared in the Agricultural Meteorological Section at Poona, giving a bird's eye view of the sequence of rainfall week by week during each year in each of the 30 rainfall subdivisions of the country for the years 1908 to 1947. These charts show up at a glance, week of excessive or deficient rainfall as well as the dry seasons of the different areas (rainfall less than 0.2" in the week).

Similar charts showing the crop condition week by week in India in symbols and figures have been prepared from the information contained in the crop reports published by the Agricultural Departments of Provinces and Indian States.

The rainfall chart as well as the crop chart for the year 1946-47 are explained and discussed. It has been shown that the destruction of wheat crop in 1946-47 by rust in the central and southern tracts was due to the unseasonable showers received in this area during the winter months of November to February which is normally a dry period for this area. Thus the very poor outturn of wheat in this area could have been foreseen by the end of January. Lack of information regarding the incidence of diseases and their intensity during past years in different parts of the country prevents one from saying definitely whether a more or less similar rainfall distribution in any year is always associated with a poor yield of wheat. The hope is expressed that, in future, the crop reports will become more colourful, containing much more information about the visible effects of weather on crops and their pests and diseases.

18. Studies on the Movement of Soil Moisture and Evaporation.

L. A. Ramdas *and* A. K. Mallik, Poona.

Some investigations undertaken by the Agricultural Meteorology Section at Poona on problems relating to the moisture balance at the surface of the ground are briefly discussed. The mean daily evaporation losses from soil surfaces with the water table at different distances below the evaporating surfaces for the black cotton soil of Poona, the red soil of Bangalore and the sandy soil of Trivandrum are given for 6 months. It has been shown that the rate of evaporation decreases very rapidly as the water table recedes lower and lower from the evaporating soil surface. Evaporation with the water table at 39″ below the surface is about 10% of that with the water table at 9″ below the surface. A quantitative relationship between the evaporation and the distance between the water table and the evaporating soil surface has been obtained. It has been shown that the mean value of evaporation Ez, when z (in cms.) is the distance between the water table and the evaporating surface, can be obtained from the equation

$$\frac{Ez}{Eo} = 10^{-z\alpha}$$

where Eo is a constant for each soil when z is equal to zero. The values of α for the black cotton soil (Poona) the red soil (Bangalore) and the alluvial soil (Punjab) are found to be 0.014, 0.015 and 0.0083 respectively. The method of calculating the mean value of evaporation from as the soil surface with the water table at a known distance below the surface is explained. When the water table is 9″ below the surface the evaporation E9″ is obtained from the equation

$$E9'' = (p1 - p2) \times 0.0334 \times V^{\cdot 17}$$

where V = the wind velocity in miles per day,

p1 = the mean saturation vapour pressure at the mean temperature of the soil (assumed to remain wet always)

and p2 = the mean vapour pressure of the air at 4 ft. above ground.

Knowing E9″ it is possible to estimate Eo or any value Ez. Such measurements and the values of α that can be computed therefrom are very useful for estimating evaporation losses from large land areas when the depth of the saturated zone and the relation between the evaporation from the small evaporimeter and that from a large area are known.

19. Effect of some Salts on the Capillary Ascent, Permeability, and Swelling and Dispersion of the Black Cotton Soil.

L. A. RAMDAS *and* A. K. MALLIK, Poona.

The effect of different concentrations of aqueous solutions of lithium carbonate, sodium carbonate, oxalic acid, lithium oxalate and sodium oxalate on the permeability and associated phenomena in the black cotton soil is discussed. It has been shown that traces of these substances increase capillary ascent but there is a rapid decrease in permeability due to the swelling of the colloidal coating of the soil particles with increase of concentration; at still higher concentrations chemical dissolution of the soil colloids restores, to some extent, the permeability. The swelling and dispersion of the soil particles also follow a similar sequence.

The effect of swelling on capillary ascent as controlled by P, the permeability and S, the pore space, at different concentrations of sodium carbonate solution is discussed on the basis of Green and Ampt's equation,

$$\frac{dl}{dt} = \frac{P}{S}(K-1),$$

where $P =$ the permeability,

where $S =$ the pore space,

$K =$ the capillary force acting on the moving boundary of the water,

and $L =$ the height of the wet soil column above the water surface.

It has been further shown that a 5% aqueous solution of sodium chloride restores the permeability of the black cotton soil rendered impervious by sodium carbonate and also moves much faster than water in the naturally occurring "Bari" (alkali) soil of the Punjab.

20. Phenology of the Wheat Crop in India.

L. A. RAMDAS, A. K. MALLIK *and* O. CHACKO, Poona.

Isocrones for the mean dates of sowing, flowering and harvesting and the duration of the wheat crop in India are discussed in the light of temperature conditions. Charts showing the frequency of night temperatures in India during the winter season are given. The mean dates of sowing, flowering and harvesting of the wheat crop, obtained from the crop-weather calendars, together with details of the temperature conditions during flowering. in the various districts of India are also given in a tabular form.

It has been shown that the wheat crop can be successfully grown only in areas where the winter temperature falls below 55°F. Further the dates of sowing are controlled by the intensity and the duration of the winter season. It has also been shown that date of flowering is independent of the date of sowing so that once the crop is sown, its development (viz., the vegetative and productive phases) is entirely controlled by climatic factors. Over the wheat zone as a whole at flowering time the air temperature varies from about 77° F during day to about 51° F during night with a mean day temperature of 64° F and a diurnal range of about 26° F. Depending upon these conditions flowering occurs later and later in the season as one moves from south to north; the delay in flowering date being of the order of 4 days for every degree variation in latitude Northwards. The duration of the growing season has also been shown to be shortest in the south where the winter season is also shortest and increases northwards as does the length of the winter.

21. An Aspect of Field Study in Soil Survey of India.

R. V. TAMHANE, New Delhi.

Owing to the varying conditions in the different parts of the country the details in soil survey will always be influenced by the nature of the local problems and the purpose of undertaking. Thus there arises the necessity of correlating the soils in one area with those of other areas so as to get a detailed soil map of India on a common basis of classification. The methods of field study used in soil survey projects at Indian Agricultural Research Institute under the guidance of Dr. J. N. Mukherjee include the following observations:

Three types of surveys (1) and the reconnaissance survey (2) the detailed-reconnaissance and (3) detailed survey are generally undertaken. The field technique and measurements as a rule include (1) Base map, prepared mostly on a scale of 4" to 1 mile for a smaller area. In all the cases the area to be surveyed is taken from the Trangulation Scheme established by the survey of India (2) Topography as expressed by contour lines of 25 or 50 feet Topography interval are generally prepared on the base map and in the field smaller intervals of 5, 10 or 25 feet are obtained by actually levelling the area of project. (3) Natural vegetation and their identification should be noted. (4) Notes on Erosion conditions, and present land use, and (5) Profile examination and collection of soil samples. This type of field study helps to form a tentative soil map on which laboratory analysis and determination help to make accurate mapping.

22. Biology, Life-History and Control of *Bagrada crudiferarum* Kirk. (= *picta* Fabr.): Pentatomidae (Rhynchota)

C. K. SAMUEL, New Delhi.

Bagrada cruciferarum (or the 'painted bug') is a very widely distributed species not only throughout India but also in some parts of Burma and Ceylon. In India, it has been reported from several places as causing damage to a variety of cruciferous crops, *e.g.*, mustard, cabbage, cauliflower, knol-khol, turnip, radish, etc. In Delhi its first appearance on brassica was noticed in the plots of the Botanical Division in December 1939, and since then the pest has been appearing year after year, sometimes becoming serious. In September 1943 the pest caused serious wilting and eventually death of numerous seedlings of young brassica crop by puncturing the central growing points and tender foliage. Adult bugs usually appear on young brassica crop about the middle of September and continue to infest the crop till its harvest in April-May. When brassica is harvested, the adults migrate to alternate host-plants, viz., *Gynandropsis pentaphylla* and *Bollanitia viscosa* (Capparidaceae) whereon they feed and breed from June to August, and when brassicas are sown in September, the pest once again returns to infest the young seedlings. The pest was also observed in small numbers feeding on wheat, maize, lucerne, berseem, cowpea, *Withania Somnifera* and *Heliotropium Ovalifolium.*

The life-history and different stages of the pest are described in detail.

Control measures tried against the *Bagrada* pest included spraying kerosine oil emulsion—nicotine compound, fish oil rosin soap (2%, 2.5% and 3%) and dusting of DDT and 666 (5%). The mortality obtained in the case of first two insecticides was 90% and 50-85% respectively. Dusting was practically ineffective. When the pest was concentrated on the field bunds, hand-picking and flame-throwing were tried and the pest was well under control.

23. Studies on the Larval Habits of the Sugarcane top Borer, *Scripophaga Nivella F.*

T. V. VENKATRAMAN, New Delhi.

There is no published record of a complete account of the habits of early stage larva of *Scirpophaga nivella* and the exact path taken by the newly hatched larva to reach the growing point of the plant. In this paper this important aspect of the early biology of the top borer is given in great detail. The just hatched larva bites out a hole on the lower epidermis of the uppermost exposed midrib, tunnels through the soft parenchymatous tissue and when it reaches that portion of the midrib which is in contact with the central leaf roll, it tunnels at right angles to the upper epidermis and enters the leaf spindle. If the newly hatched larva cannot get into a midrib it dies for want of protection and food, which at this stage is the soft parenchymatous tissue of midrib.

Some varieties of sugarcane are more resistant to the top borer than others. The morphological characters of the sugarcane plant that appear to be of importance in the relationship between the pest and the host plant are: (1) The amount of lignified tissue concentrated on the lower side of the midrib varies with different varieties. (2) If the just hatched larva cannot bite out a hole in the midrib within a certain period from the time hatching due to the hardness of the lignified tissue, it dies. (3) Comparative midrib hardness is one of the factors which affords resistance to the sugarcane top borer.

24. Preliminary observations on the control of the potato tuber moth *Gnorimoschema Operculella*, Zell. (Lepidoptera: Gelechnidæ) by its Natural Parastic Brason (Microbracon) Gelechiæ Ashin, (Hymenoptera: Braconidæ) (Hymenoptera: Braconidae).

E. S. NARAYANAN, New Delhi.

The potato tuber moth, *Gnorimoschema operculella* Zell., is a serious pest of potato in storage. The moth lays eggs in the eyes of the tuber, and the larve that hatches out tunnels into tubers and render them unsuitable for human consumption. The storage of this valuable food stuff in or near the centres of production for varying periods is almost unavoidable and it is in the national interest that the damage caused by the tuber moth larvae should be reduced to the minimum.

Bracon (Microbracon) gelechiae Ashmead is one of the well known natural enemies of the tuber moth larvae in U.S.A. and Canada, where the depredations caused by the tuber moth larvae is kept under fairly effective check by this parasite. This exotic parasite was imported from Canada in 1944 and in the Entomological Laboratories of the Indian Agricultural Research Institute, the parasite is bred in thousands. The results of the preliminary experiments indicate that the parasite can to a great extent reduce the pest population. With the same initial infestation it was found that the emergence of the moths from the control trays was five to seven times more than from the experimental trays in which the parasites had been liberated.

25. Preliminary Studies on a Chemical and Physico-Chemical Control of the Leaf-Curl Disease of Tobacco.

B. RAMA MOORTY, S. V. DESAI *and* C. K. SAMUEL, New Delhi.

The leaf-curl disease of tobacco is known to be a virus disease transmitted by the white fly Bemisia tabaci (Gen.). The physical and nutrient conditions in the soil are generally known to be important for the development of certain diseases caused by fungi and have lead to the starting among mycologist a school of "Predispositionalists" and another school opposing this. There is therefore a great need for experimental

evidence on the influence of plant nutrition on infectious diseases like the leaf-curl diseases.

In the course of experiments carried over three years, manurial treatments were found to have a great influence on the resistance to the leaf-curl disease of tobacoo. Three kinds of observations were made. (1) Out of the differently manured plants, those treated with N carried maximum of disease while those treated with P carried no disease. Treatment P+N was intermediate. This result was the same either when the plants were left to the natural conditions of disease infection or when they were artificially infected with disease carrying white flies. (2) The P|N ratio of the healthy leaves was higher than that of the corresponding diseased counterparts. (3) The disease symptoms could be arrested even in the susceptible farm yard manure treated plants even after the onset of the disease by secondary additions of superphosphate at a later stage. The corroborative inference from these three types of observation was that additions of nitrogenous manures increased the susceptibility while those of P increased the resistance to the leaf-curl disease. Some of the predisposition to disease as a result of heavy nitrogenous manure could be reduced by the application of B, Cu, Mn and Zn. But definitely better results could be obtained by the addition of super instead of these minor elements.

Differently coloured mulches also showed varying degrees of resistance to disease indicating the influence of soil temperatures in controlling the susceptibility to leaf-curl disease.

It is proposed to continue the experiments to confirm the interesting results so far obtained.

26. Some Biochemical Studies on Nitrogen in Soil and Manures.

S. V. Desai *and* B. V. Subbiah, New Delhi.

As the principal biological processes in the soil are those of hydrolysis and oxidation, the solvent action of 80% sulphuric acid has been suggested by several workers for characterising the soil organic matter and for differentiating relatively easily decomposible material and material resistant to bacterial activity.

From the point of both nitrogen and carbon, hydrolizable by 80% sulphuric acid, the manures studied were found to be of the following order:—Farm yard manure, compost, cowpeas, mustard cake and activated sludge. Both the total C|N ratio as well as hydrolizable carbon to hydrolizable nitrogen tallied except in the case of last two in which the order was reversed.

The relative nitrifiability of these organic manures as determined in the laboratory incubation experiments was found to be in the decending order of (1) Mustard Cake (2) Activated sludge, (3) Green manure, (4) Compost and (5) Farm yard manure. Addition of inorganic nitrogen invariably increased the amount of nitrogen nitrified. The nitrification values were found to depend more on the sulphuric hydrolizable carbon and sulphuric hydrolizable nitrogen ratio than on total C and total N.

The straight line graph obtained by plotting the nitrate formed with ratio of hydrolizable nitrogen to the carbon oxidised during incubation showed that nitrate formation was dependent upon hydrolizable nitrogen

Further the hydrolizable nitrogen of manures and soils was also found to be correlated with yields and nitrogen recovered by the crop in the field experiments at Delhi.

These results suggest that the mineralization of nitrogen depended on the 80% sulphuric acid hydrolizable nitrogen and that determination of this fraction is useful in judging the nitrogen availability to the crop.

27. A Preliminary Study of a Few Sampling Sizes for the Growth Observation of Field Cotton.

P. S. SREENIVASAN *and* T. S. GOVINDASWAMY, Poona.

Three sample sizes namely 8, 16 and 24 foot-rows made up of two parallel 4, 8 and 12 foot length in two adjacent rows respectively were tried for making quantitative growth observations on field cotton. It was found that there is no appreciable gain by adopting bigger sample sizes for observing the mean number of plants per unit length, mean height of plant, number of monopodial and sympodial branches. But in the case of mean number of flowers per unit length, there is an appreciable decrease in the coefficient of variation when the sample size is increased.

28. A Statistical study of the growth of Sugarcane at Poona.

V. K. RAMABHADRAN, K. S. KRISHNAMURTHY *and* P. S. NAYAR. Poona.

In this paper growth curves are fitted to germination counts, height of cane and the brix reading. It is found that germination and 'brix' follow the law

$$\frac{dy}{dx} = a(k-y)$$

where a and k are constants. The height, however, follows a more general curve, *viz.*,

$$\frac{dy}{dx} = f(x)y(k-y)$$

where $f(x)$ is a function of time (x) and k is a constant.

Each growth phase of the sugarcane crop is thus conveniently represented by a set of "growth constant". Such a process summarises the entire life history (from sowing to harvest) of the crop. These constants as well as those representing the variations in the climatic factors vary from year to year and can be correlated with the variations in yield.

29. Intraclass Correlation and Sampling Efficiency.

V. K. RAMABHADRAN, K. DASARADHA RAMARAO *and* J. G. GRIFFITHS, Poona.

The paper discusses the efficiency of the 8' linear sampling technique for sugarcane by calculating intraclass correlations for the weekly observations of height. It is found that such a sampling is suitable for the sugarcane crop

30. A note on the Biology *Poecilonola plagiola* Hmpsn. (Arctiadæ).

B. B. BOSE, New Delhi.

The food plant of the caterpillar of this moth which belongs to the family Arctiadae was discovered in 1943 at Delhi although the moth was described as far back as 1898. The caterpillars feed under natural conditions on the leaves of *Eriobotrya japonica* Lindl. (loquat) which is a luscious Chinese fruit and is grown all over India but much more successfully in the North West of India and the fruits are available in the market for sale during summer and upto October in Delhi.

A coloured plate has been prepared showing the caterpillar, pupa, cocoons and a female moth. The pupal period in captivity was 17—10 days in February-March 1943, and the caterpillar is characteristic as it has only 3 pairs of prolegs on the 4, 5, 6 abdominal segments and carries a chain of head moults over its head almost vertically. The larva, pupa and cocoons have been described.

31. Virus Diseases of Sann-Hemp (*Crotalaria Juncea Linn.*) in India

S. P. RAYCHAUDHURI, New Delhi.

Three virus diseases have been observed on sann-hemp (*Crotalaria juncea* Linn.) so far in India; these are Mosaic, Smalling and Leaf-curl.

Symptoms of the three diseases are described in detail. In the case of mosaic, characteristic mottling is the chief symptom while in smalling and leaf-curl sterility and development of enations respectively are the distinguishing features. Mosaic and smalling are transmissible by sap-inoculation while leaf-curl is not sap-inoculable, although it can be successfully transmitted by grafting. Host-range of all the three viruses has been studied.

The mosaic virus has a thermal death point of 68°—70°C., longevity *in vitro* of 71-76 days and can tolerate a dilution of between 1 : 1,000—1 : 5,000 while the smalling virus has a thermal death point of 85°—90°C., longevity *in vitro of* 41- 50 days and can tolerate a dilution of 1 : 25,000—1 : 30,000. No evidence of seed transmission has been observed in the mosaic and leaf-curl diseases.

32. Climatic Factors Responsible for the outbreak of Agrotis Pests.

A. C. SEN, Sabour (Bihar).

Very little information is available on the ecological aspects of *Agrotis ypsillon* Rott. which is the most serious pest on the 'Rabi' crops such as wheat, gram and pulses etc., in the low lying areas in Bihar. The first report of the pest in Bihar, is usually noted either in the last week of September, or in the first week of October—depending upon the 'Hathia' (October) rainfall. It has been observed that if this Hathia rain be of intermittent duration or lesser, there is then every possibility of epidemic of this pest. Two reasons can be ascribed to this, viz., (1) weeds thrive well under less flooding conditions and serve as food-plants to the pest, whereas, under heavy rain conditions the low lands remain submerged under water for a longer period and as such, are not fit enough for ovoposition by the pest, nor the weeds are grown earlier to give the ready available food plants. (ii) Soil cracks form an ideal site for the moths to the hide and to lay eggs; under heavy flood conditions this crack formations are much delayed.

Early 'Hathia' rain and consequently early receding of the food water, on the other hand, has been found to be very suitable for ovoposition by the pests. Monsoon rain has no effect on the prevalence of this pest.

33. Role of the Entomology in the Grow More Food Campaign.

A. C. SEN, Sabour, (Bihar).

The incidences of pest infestations are as much dependent on the ecological conditions as on the availability of food plants. Hence, in all our attempts on the intensification of the Grow More Food Campign, the correlation of the insect fauna with the plant flora should receive first priority and be never overlooked. Grow More Food Campaign should not give rise to Get More Pest Populations.

The disturbances of the crop-rotations and excessive cropping are very likely to give rise to overlapping of the life cycles of certain pests without any break. Unless suitable types of soil and host plants are selected, it would very likely increase the termites and caterpillars in the fields. When requisite chemicals are not easily available, nor are within the purchasing limits of the cultivators, we should give more attention to prevent the occurrence of the pests by inexpensive cultural operations, rather than to resort to chemical warfares in the control of the pests.

A few examples were cited as how in altering the date of sowing, depending on the 'Hathia' rain, the damages from the notorious *rabi* crop pest *Agrotis Ypsillon* Rott. can be greatly averted, how the early paddy, the 'Colaba' variety, can be grown advantageously on a large scale in certain tracts where *Leptocorisa varicornis* F. is rare, how harvesting the potatoes by the middle of February saves the vegetable to a great extent from the *Gnorimoschema operculella* Zell.—all these have been proved by large scale field trials in Bihar.

34. Effect of different forms of Phosphate and their combinations with other manures on Berseem and after-effect on Maize.

S. Sen, New Delhi.

Experiments were carried out at the I.A.R.I. Farm, New Delhi to test the effect of superphosphate, bonemeal, basic slag and ammonium phosphate singly and in combinations with farm-yard-manure, green manure and sulphate of potash on the yield of berseem green fodder and after effects on the succeeding crop of maize. The results of these experiments suggest that ammonium phosphate has better effect on the yield of berseem and in building up the soil fertility, as reflected by the following maize yields, than other forms of phosphate. The best yields were obtained with phosphates in combination with potash or farm-yard-manure. Bonemeal indicated negative effect. Further, basic slag showed a definite manurial value, comparable to superphosphate, on both the crops.

SECTION OF PSYCHOLOGY AND EDUCATIONAL SCIENCE

PRESIDENT: DR. ZAKIR HUSAIN, M.A., Ph.D.

1. Psychological foundations of communal conflict.

P. S. NAIDU, Allahabad.

The present communal conflict has its roots deep in the irreconcilable antagonism between Hindu and Muslim cultures. Culture should be analysed psychologically, and the only school of psychology competent to undertake the task is the Hormo-Analytic school. Hormic psychology analyses culture in terms of the origin and evolution of mental structure of individuals, as well as of races or nations or groups. The inherited elements of mental structure and their development as a result of their contact with the environment, human and sub-human, are sketched here on the basis of Hormic psychology. Account is also taken of the Unconscious in shaping the course of mental evolution, and in the formation of culture patterns. In all this process, it is shown that the MASTER SENTIMENT AS DEFINED BY McDOUGALL plays the dominant role. The master-sentiments of Hindus and Muslims are shown to be completely antagonistic. There is no possibility of psychological reconciliation. An honest recognition of fundamental differences is shown to be the only way for communal peace.

2. Koh's Block Design test.

P. S. NAIDU, Allahabad

1. Introduction—A critical estimate of the claims of Koh's test to serve as a test of 'g' factor
2. A survey of recent attempts made in U.P. to adapt Koh's test to local conditions.
3. Formulation of our problem, confined to 11 plus
4. Details of adaptation of the full battery (as used by Koh), and of the abridged battery (as used by Collins & Drever)
5. Validating check-up by correlation with Allahabad Group Verval test for 11 plus.
6. Results and Discussion.
7. Final conclusions.

3. Projection tests of personality.

P. S. NAIDU, Allahabad.

1. Historical Survey of the foundations of Projection methods.
2. Role of Psychoanalysis and Gestral theorie in determining test methods.
3. Techniques of the newer child-analysis and their influence on personality assessment.
4. The Thematic Apperception Test—a critique.
5. The Rorshach Technique—a critical estimate.

6. A consideration of the concept of personality assumed in these techniques
7. Suggestions for a new type of Projection technique combining TAT with the story method.
8. Discussion and conclusions.

4. Discriminating capacity of items of a Word Association Test List.

S. K. MITRA, Patna.

As part of research on the technique of Personality Testing at the Institute of Psychological Research & Service, Patna, analysis of response of different items of the Word Association Test used was undertaken. An attempt has been made in this paper to differentiate items on the basis of their eliciting significant personality pointers. Some items have greater power to reflect individual differences than other items. Certain theoretical observations follow.

5. Language Development in the Child of Two.

G. C. MATHUR, Patna.

A record of speech development of a child was maintained for about a year from the age of one. An attempt has been made to relate the speech peculiarities and increasing vocabulary with the environment of the child as far as possible. Some emotional characteristics of the child have also been noted.

6. Motivation for college courses.

S. C. SRIVASTAVA, Patna.

The purpose of the enquiry reported in the paper is to determine on the basis of a specially prepared questionnaire the tendencies of preference for special subjects of study in College Courses and the motives for the same. The present report covers 80 cases of College students. Certain practical remarks suggested by the findings of the enquiry are also made.

G. KAPAT *and* C. C. BHATTACHARYYA, Calcutta.

7. Some observations on Passalong Test.

The present paper is based on Passalong Test Results of about 750 boys and girls of varying ages ranging from 9 to 25 years. It presents tentative age norms and also attempts to show the correlation between Concrete Intelligence as measured by the Test and Abstract Intelligence as measured by Terman's Tests. The question whether Passalong Test Scores can be expressed as I. Q. has been discussed.

8. Freud's psychology of philosophy.

P. N. BHATTACHARYYA, Calcutta.

The paper aims at unfolding and criticising Freud's psycho-analysis of philosophy. His reduction of philosophy to psychosis is based on misunderstanding. This Freud could have averted if he had subjected philosophers to analysis and then arrived at generalisations, instead of relying upon second-hand materials,

9. Localisation of 'One-Point' Sensation produced by Double-Point Stimulation.

S. Warrior, Patna.

The paper presents a comparative study of accuracy in localisation of sensation of a single touch stimulus and of 'one-point' sensation in the same area of the skin due to stimulation by Aesthesiometric needles. Phenomenological differences are also noted.

10. Study of Industrial accidents in a Textile Mill.

K. C. Mukherji, Patna.

This paper is based on an investigation on incidence and factors of accidents among factory workers in the New China (Textile) Mill, Seuri, Bombay. Certain remedial steps are suggested.

11. A study of Correlations on Performance Tests.

G. Kapat, Calcutta.

Results of four Performance Tests *e.g.*, Pass-along, Dearborn Formboard, Koh's Block Design, Cube Construction, are reported. The paper presents inter-correlations of the different Tests as well as correlation between Concrete intelligence as measured by the Tests and Abstract Intelligence. The questions of validity and reliability also have been discussed.

12. The Psychological factor behind recent Labour unrest in India.

Bepin Behary, Patna.

(1) Upward trend in the graph of Labour strikes in recent years.

(2) The Economist's explanation in term of rise in cost of living not sufficient.

(3) Importance of the psychological factor of increasing frustration feelings needs emphasis.

(4) Labour unrest and recent communal strife seem to arise from the same background of frustration feelings among the masses.

13. Criteria of interpretation in Personality Testing.

H. P. Maiti, Patna.

1. Fundamental importance of determination of personality pointers in any Guidance or Selection programme.
2. Though interpretation is essentially an art, depending on the practice, training and mental equipment of the interpreter, theoretical analysis of the criteria and methods of interpretation would be necessary.
3. The current assumption that the psychiatrist is specially fitted for the interpretive art is examined.
4. Certain conditions and principles of valid interpretation enunciated and explained.

(Reference has been made in the paper to Tests and Test procedures used at the Institute of Psychological Research and Service, Patna).

14. Estimation of a man's probable success in a vocation.

G. PAL, Calcutta.

Four tests (namely $Z1$, $Z2$, $Z3$, $Z4$) were given to 50 Mechanical Engineering apprentices. Proficiencies of these 50 men in Mechanical ability (say ZO) were assessed and ranked by their Superior Officers.

Correlations of these ranks with each of the four test scores, as well as the intercorrelations of the test scores were calculated. The Values of the coefficients a, b, c, d of the regression equation $ZO = aZ1 + bZ2 + cZ3 + dZ4$ were determined by the Aitken's method. In the present case the equation becomes $Zo = '479Z1 + '150Z2 + '267Z3 + '108Z4$ where $Z1$, $Z2$, & C represent the standardised Scores.

To predict the success of a man in the Vocation of Mechanical Engineering Zo—the person is examined in the four tests. The standardised scores are then substituted in the equation and the predicted score in Zo is obtained.

15. Analysis of a set of tests into independent factors.

G. PAL, Calcutta.

5 tests were applied to 100 College Students. Values of intercorrelations of test scores were calculated.

Hierarchial relations of spearman were not found to be satisfied.

Thurston's method of analysis was applied. Loadings of each of the independent *factors* as well as those of the specifics were calculated.

Interpretations of these factors in Psychological terms were suggested in the paper.

16. Factors in Number Choice.

RAM MURTI LOOMBA, Lucknow.

A study of the conscious factors in number choice revealed by introspective reports obtained from University students with the help of a questionnaire devised for the purpose.

17. Individual Differences in Imagery.

T. K. N. MENON *and* S. C. PARIKH, Baroda.

Studies made on the above subject are not many; the importance of imagery in thinking, learning, aesthetic appreciation etc., demand more research on the question. The prresent inquiry was aimed at to find out among other things whether individuals are capable of evoking all or only particular kinds of imagery and whether the classification of individuals into visiles, audiles, tactiles etc., has any justification.

The subjects chosen were 54 graduate teachers undergoing professional training in the Baroda Training College. The subjects were asked to form voluntary images of 50 items, 5 belonging to each of 10 types. They were asked to mark the images in terms of vividness (Grade of vividness:—Very vivid; 6; Vivid: 5; Clear: 4; Moderately clear: 3; Vague: 2; Very vague: 1; No image: 0).

The analysis of the data made on a group and individual basis and its graphical representation resulted in the following conclusions:—

(1) Individuals differ very much regarding the vividness of images of different types they form.

(2) Visual images rank highest in respect of vividness with auditory and tactual ranking next.

(3) There is no evidence to prove that a person is not capable of forming all kinds of images.

(4) Particular individuals show difficulty in forming even moderately clear images belonging to some types.

18. Performance of the Arts and Science Graduates at Professional Examinations.

L. J. BHATT *and* S. C. PARIKH, Baroda.

There are divergent views regarding the relation of 'the knowledge of theory with "efficiency in teaching." Some people believe that a fairly satisfactory knowledge of theory accompanied by plenty of practice will lead to efficient teaching while others opine that plenty of theory work with some practice will enable to be a good teacher. A reference to the recent change made by the Bombay University re: weightage to theory and practice in the B. T. syllabus may be made. Until recently equal weightage was given to theory as well as practice at the B. T. Examination. Since 1944 more weightage is given to theory and less to practice.

'Does the knowledge of theory help a teacher to better skill in teaching?' With a view to answering this question, the achievement of teachers in terms of marks at Bombay University B. T. degree examination is analysed in this paper. Two batchehs of Arts and Science Graduates who were admitted to training in Baroda Training College in the years 1944—45, 1945—46 are selected for study. The data consists of (1) Qualifications, (2) Marks in Part I and Part II of the B. T. degree examination—*i.e.*, achievement in theoretical and professional parts of training. The Rank Difference Coefficient of Correlation point to the following conclusions:—

(1) There is justification to assume that a sound knowledge of the theory of Education brings with it skill in teaching practice;

(2) The relation between the knowledge of theory and skill in practice is higher in the case of Arts Graduates than with Science Graduates.

19. Passalong Test.

D. GANGULY, Calcutta.

This test forms a part of the battery of tests that are being used in connection with the vocational guidance work of the Applied Psychology Section of the Calcutta University.

While using the test, the following points were observed:

(1) In this test as in all other types of performance test chance plays some part in the solution of problems with those persons who attack them with no plan. The probability of such chance solution is considerable in the case of sub-test no. 8 of the passalong test because of the local positions of the wooden blocks. It has been observed that some persons are in the habit of manipulating objects with one particular hand and in one particular direction. If the smaller blocks in sub-test no. 8 be placed on the right hand side of the subject and if the testee works in a clock-wise right-handed manner the chances of success become much greater than when the smaller blocks are placed on his left. The subject in action in previous sub-tests should therefore be carefully observed and his habit detected so that the blocks for sub-test no.8 may be presented before him set in such a way as to obviate the chance factor.

(2) If we pursue the figures of sub-tests nos. 7, 8 & 9 of the passalong test we shall see that each one of them is composed of same type and number of blocks only differing from one another in their arrangement. Only one more arrangement is possible which has been left out of consideration in the standard test. The figure of this new arrangement may be taken as sub-test no. 10; it falls in line with the progressive difficulty of the sub-tests. Its inclusion will make the whole test scores more smooth and comprehensive.

20. Mind in the Scale of Evolution.

(A study in Indian Psychology)

K. C. MUKHERJI, Calcutta.

Biological evolution implies differentiation. This is also true of the Samkhya concept of evolution. But there is fundamental contrast in the order of evolution between the concepts. So the position of mind becomes anomalous even though both the concepts maintain purpose in the order of evolution.

21. Is 'G' an Act of Will?

K. C. MUKHERJI, Calcutta

It has been observed that success in Intelligence Tests depends greatly on concentration which dispels distraction caused by other factors. The high correlation of results of the Terman Tests and Passalong Tests suggest close affinity between 'G' and high attentive consciousness which is involved in the performance of Passalong Tests.

22. Measurement of Love-Urges.

J. C. DAS GUPTA, Calcutta.

love urges of 104 persons of which 42 are adults of different ages and 52 children, by the help of a questionnaire of 41 items. The questionnaire scores are correlated with ratings of individual love-urges by skilled observers. Validity of questionnaire devised and applied is claimed. The mean scores for children of different ages as well as those for married and un-married adults are given. The Psychological significance of different types of answers is indicated.

23. Mind-Image.

MISS A. SINHA, Patna.

Apart from the logical concept of Mind, individuals differ as regards their ways of imagining it. An investigation was carried out to study these differences by an introspective questionnaire. Certain broad types of mind-imagery are indicated.

24. Mental Age *versus* Grade Placement.

J. M. SEN, Calcutta.

Wherever mental tests have been given in primary or secondary school classes, wide variability in the mental age of pupils has been the condition commonly found. It is not unusual to find in the same class pupils differing in mental age by as much as four years. Nor are the variations in attainment in any phase of school work

usually discovered to be much less. Yet to most school teachers these conditions seem far less disturbing than wide variations in chronological ages. The latter condition results, of course, whenever gifted pupils are allowed to skip grades or backward pupils are required to repeat grades. Whenever ability grouping is feasible, this condition, however, can be largely eliminated. But the fact that many backward pupils are still likely to be found in grades in advance of their mental ages, while many gifted pupils are discovered in grades far below where their mental ages would place them, raises the question as to the comparative importance of grade placement and mental age in school attainment. Gifted pupils not infrequently do a poor quality of work in comparison to their capacity. Is it then, superior attainment of the less gifted, and low attainment of the gifted pupils, that accounts for the wide variability in attainment and mental ages in the classes. The paper discusses the problems connected with the above questions.

25. Mental development of premature Children.

K. D. GHOSE, Calcutta.

Criterion of judging prematureness—weight rather age, less than five and half pounds. A study of fifteen premature children undertaken about ten to twelve years ago i.e., between 1935-37 and carried on since then. Their bodily condition at time of birth and a little later. Their physical and mental growth. Catching up full term boys in weight by the fourth or fifth year. Premature girls slightly under weight in comparison with full term girls. Doubts as to mental development. But no difference in mental ability after the fourth or fifth year, the school rating and intelligence testing being equally good. The great advance modern science of pediatrics has made in overcoming the deficiencies of intra-uterine life. Prematures have a curious mental attraction for one another. Cases of famous prematures like Newton, Darwin, Cuvier, Napoleon, Voltaire, Hugo, Lamartine, Renan and others. The prematures studied progressing satisfactorily except one who succumbed to ricket and anæmia in his fifth year. On the whole, provided sufficient care is taken of them early, prematures thrive mentally just as much as full term children and history records outstanding achievements of famous prematures.

26. The place of English in Secondary Education.

K. D. GHOSE, Calcutta.

Elimination of British rule marks a new epoch in our educational annals—the status of English has to be considered on its own merits as distinct from the language of the ruling race.

The position of English as a world language. The claims of English and Russian considered especially. English spoken over a larger number of important countries.

The great advantages of English for this country.

In a selective Secondary System with Basic Education absorbing the bulk of the school-going population, English should be not merely an optional language but a compulsory second language from Class VII or VIII onwards i.e., from the age of twelve or thirteen. Difficulties as to introducing it at the College or University stage.

The attention in the future is to be devoted to mastering this language in a shorter time by simplified systems or better methods of teaching.

27. On Personality-Matching in selection.

P. D. SHUKLA, Simla.

The importance of personality pointers cannot be over emphasized in the modern scientific method of selection. But for correct selection to be made it is very necessary that the pointers not only interpret the personality correctly but also are uniform in their award of grade. How can we test whether this truth is being achieved by a particular selection organization is suggested in this paper in the form of a statistical experiment.

The paper also incorporates the results of such an experiment conducted on a purposive sample of pointers taken from the Employment Selection Bureau records. The matching is done both quantitatively and qualitatively.

28. A future of Neo-Hormism.

A. K. SARKAR, Colombo.

The article is an attempt to consider possible neo-hormic tendencies in psychology. Naidu chooses Mc Dougall as the best exponent of the contemporary hormic tendency in psychology. He suggests that if Mc Dougall sticks to his original theory of the three-fold analysis of the instincts rather than the two-fold analysis of his later books, he will be able to avoid contradiction.

McDougall however, can be brought nearer Freud if he follows the two-fold scheme of the instinctive activities, admitting a natural evolution of mind in terms of Drever and Rivers. The affective and the conative aspects of mental life are biologically relative and mutually convertible. This tendency will further close up the gulf between the normal and abnormal mental life so often stressed by Freud and McDougall. We shall be drawn nearer to the suggestions of the subliminal self of Myers and Tyrrell, interpreting the phenomena of telepathy, foreknowledge, and the expressions of supernormal personalities, as normal, or as expressions of deeper self which was not recognised previously. But we prefer to suggest that the development of the hormic or neo-hormic tendency along all these directions. should be interpreted symbolically as to admit other ways of development without dogmatising in any one direction.

29. Intelligence Test Scores of 400 I.Sc. passed students as compared with their University Examination Results.

S. K. BOSE *and* S. C. DATTA, Calcutta.

The paper presents a study of correlations between the intelligence test scores of 400 students who were candidates for admission in the Calcutta Medical College in 1947 and the total marks obtained by them at the I.Sc. examination of the Calcutta University. An 'omnibus' type of test was prepared and used as a group test. The candidates were graded on a five-point scale from the plottings of the test scores. The gradings were compared with the University results. Positive correlation was obtained in most cases, but there were several cases of discrepancies in which students with high University marks had low intelligence scores. Scrutiny of the answer sheets of these students revealed interesting features which at least partly explained their failure in intelligence tests.

The results of testing on the whole tend to support the contention that intelligence test

scores are more dependable guide for judging abilities in practical fields than examination results.

30. Language and Society.

S. K. Bose, Calcutta.

Human beings live in social groups, and certain recurrent typical situations in the life of the various social groups largely mould the language behaviour of these groups. Language is not merely a vehicle of communication, but the warf and woof of social bounds and obligations. Deriving its force and cogency from the social life a common language assumes the command of the driving power of the society.

The present paper supports the above contention by referring to modes of linguistic expressions of typical social groups or communities of our time.

31. Bases of payment in Industries and their effects upon the employee morale.

S. K. Bose, Calcutta.

The paper discusses the relative advantages and disadvantages of the Time, Speed and Incentive bases of payment in modern industries, with special reference to the likely effects of the different systems of payment on the moral of the workers. A short critical survey of the present-day systems of payment—Halsey plan, Premium plan, Gantt task and bonus system, Bedaux system, etc. has been given, and a few observations have been made about the workers' point of view on the basis of impression gathered by the writer by interviewing several workers in factories.

32. Regression in teaching profession—A Survey.

T. K. N. Menon *and* L. J. Bhatt, Baroda.

Growth is the chief characteristic of a master teacher; it is limited by the time and circumstances on which a teacher has no control. What factors—social, economic and personal—contribute to *growth* vice versa *regression* in teaching? Can there be ways and means to check this tendency to regression?

With a view to studying the factors which contribute to regression, a form with 30 items was devised and answers were elicited in writing from a batch of 35 teachers who attended a refresher course organized by the Baroda Training College. All had put in a service of ten years and more after training. The answers make following conclusions evident:—

(1) All teachers were depressed by their financial circumstances, and lack of status told heavily upon their attitude towards profession;

(2) They were doing heavy work hence their interest in reading and extra-curricular activities was meagre;

(3) All of them expected some external agency like Department of Education or Pay Commission to help them;

((4) Efficiency, thus, should decrease if the job does not reward a person with satisfaction, does not stimulate him toward further growth nor facilitate the attainment of comforts and fulfillments which are basic to decent human living;

(5) It is desirable to consider both how a person does the job and what the job does to the person who is responsible for conducting the work.

33. Preference Test of School Children for Different Subjects.

MRS. SHANTA DEB, Calcutta.

This paper is an attempt to find out preference of school children regarding different school subjects. Nearly three thousand school children belonging to twenty different Institutions of Bengal have been tested. Three different tests have been given to each child and the results of these three tests have been calculated statistically. The graphs show how the interest for different subjects vary in different age.

Many defects of our present day educational system come to light as well, of which the most outstanding is that the children of different age-groups are put together in the same grade according to their intellectual ability without any consideration of their mental age.

34. A study of the development of the concept of Class-names in Children.

J. RAMACHANDRAN, Madras.

An attempt is made in this paper to study the development of the concept of class-names by means of a 'Class-name Test' in Tamil given to 655 children of grades IV and V from 8 different Schools at Madras. A quantitative analysis of the results revealed among other things: (*i*) The difficulty of the problem as is evident from the low mean scores. (*ii*) Superiority of girls over boys especially after 9+. (*iii*) The close relationship of conceptual development to educational attainments as revealed by the superiority of 8 year olds of grade V over the 12 year olds of grade IV. (*iv*) Superiority of the mentally-skilled groups over the manually semi-skilled groups as is evident from a study of results based on the occupations of the fathers. A qualitative analysis of the wrong type of answers written by considerable number of pupils revealed the preponderance of 'Definitions by use', 'Descriptions of things', 'Places where things are found', for both boys and girls.

35. A Comparative Study of Thought Process in Schizophrenics and Maniacs.

K. A. SUMITRAN, Madras.

The purpose of this study is to obtain the exact differences that are found in the performance of three psychological tests in Schizophrenics and Maniacs.

Eight patients from the Govt. Mental Hospital, Madras were chosen, four belonging to each group.

The following tests were administered:—

1. Number series Completion Test (2) Absurdities Test and (3) Analogies Test.

The Schizophrenics fared better in Number series Completion Test than in Absurdities Test.

The Maniacs have scored very high or very low in both Number Series Completion Test and Absurdities Test.

All the eight patients have scored their highest in Analogies Test. In this test the Maniacs kept, more or less, a consistent high level of scoring while the Schizophrenics showed wide range in their scores.

An analysis of the mistakes in Absurdities Test revealed the following characteristics of thought deterioration in Schizophrenics and Maniacs.

Schizophrenic thought characteristics in the order of their deterioration:— (1) Lack of superficial integration of ideas (18 mistakes) (2) Lack of insight after superficial integration of ideas (14) mistakes)

(3) Inhability to feel contradictions (3 mistakes) (4) Usage of unconnected ideas because of "concrete thinking" (17 mistakes)

Maniac thought characteristics in the order of their deterioration:—

(1) Lack of insight after superficial integration of ideas (14 mistakes)
(2) Lack of superficial integration of ideas (1 mistake)
(3) Usage of unconnected ideas (5 mistakes).

36. Colour preference of Hindustani Students.

HAKIM IFTIKHAR ALI KHAN, Lucknow.

The present investigation of the colour preferences of Hindustani students makes use of the materials and the technique suggested by Garth. Analysis of data so far obtained (N = approximately 500) shows the order of preference to be: Red, Yellow, Blue, Green, White, Violet, and Orange.

Certain theoretical points are discussed in the light of our findings.

37. Forecasting of Teaching ability.

HAKIM IFTIKHAR ALI KHAN, Lucknow.

The paper reports the success of an inventory consisting of 21 items in judging teaching ability efficiency. The inventory was tried on 64 students of training class of Lucknow University and validated against the ratings of supervisors. The correlation between supervisors' rating and score on inventory was found to be + .14 + 0791

38. Fatigue and Efficiency in Textile Industries— a Report.

KALI PRASAD *and* HARI SHANKAR DUBEY, Lucknow.

Last year a scheme was submitted for an enquiry on 'Fatigue & Efficiency in Textile Industries' to the Indian Research Fund Association, Government of India, New Delhi. A small grant was sanctioned for the purpose. The work is being carried on in the Experimental Psychology Laboratory at the Lucknow University.

The object of the enquiry is to measure the fatigue & efficiency of the workers. The work has been started in the first instance in the Swadeshi Mills at Cawnpore. In the course of our investigation we are utilising the records of the working capacity of the workers in the factories. These will be supplemented by the laboratory tests which will consist both of muscular and some mental tests. The following will serve as indices of fatigue:

(1) The Output Rate
(2) The Consumption of Power
(3) The Accident Rate
(4) The Proportion of Wastage to Output
(5) The Proportion of Sickness and Ill-health among the Workers

We hope to find out the major disturbing factors that operate upon the workers and make for their inefficiency and ill-health. Recommendations will then be made in regard to the maximum number of working hours and spells, improvements in the working environment and the application of healthy incentives.

39. A note upon the analysis of 331 'personnel officer candidates' test data at the Tata Iron & Steel Company Limited, Jamshedpur.

S. JALOTA, Jamshedpur.

The candidates were put through a selection procedure consisting of general intelligence tests, personality tests and group discussion tests. All of those tests were given and evaluated by Dr. D. L. Sharma and myself, both of whom have had extensive experience of personal selection procedure. The age range of candidates was 21—53.

We found that (*i*) Age has a high negative correlation with intelligence test-scores. Some conclude that in the selection of older age groups we should consider other factors besides the factor of intelligence test score. (*ii*) Multiple correlation coefficient of the final grade with the rest of the tests in quite high:

$$R\ 1234 = +\ \cdot 759\ : \qquad O\cdot 1\ 234 = 5536$$

This figure compares favourably with the 'g' Saturation loading of the Final Grading (according to Spearman's method) of .759; and the communality of the same (according to Thurstone's method) of .712, (*ii*) The relative importance of the following factors in the Final Grading was obtained from the *beta* coefficient of the second order: Group discussions score — 50.6%; Verbal Test Score = 38.39%; Personality Score = 11.1%.

Non-Linear correlations were also obtained. Several of them were significant. Other interesting results of the comparison of Linear and Non-Linear Correlation data are also given.

40. Response Psychology and Religion.

SRIMANT LAL DAS, Patna.

The paper deals with the implications of Response Psychology in relation to religion. 'Response Psychology' is the name proposed for a new science to deal with the responsse (or reaction) of the external world (to man's inner mental state) and the response (or reaction) of the inner world (to man's inner mental state).

The domain of the supernatural in religion must shrink, and certain religious phenomena may be explained by laws of nature which we find true in our every-day life.

A fair portion of the supernatural and miraculous in religion and life is nothing but the response of the external world or the response of the inner world.

Phenomena like intellectual illumination, inspiration, a number of religious revelations, a large number of dreams that play such an important part in religious literature, Conversion, the Inner Voice, etc. are often but instances of response of the inner world. There may be absolutely no mysticism about them.

With his own experiences of 'Sharnagati' and insight in the working of the response law, the author sees nothing supernatural or miraculous in the achievements of Gandhiji.

41. Study of an insane man.

UDAI BHANU, Indore.

Ten insane persons were kept under observation. But the causative factors underlying their abnormal functions were so different that it was not possible to generalize and formulate specific laws governing them. Therefore, one man was selected. This paper is the study of his behaviours for six months.

The abnormality in his reactions was so clear that any man could notice it. There was nothing wrong in his situation. This shows that the real course of the trouble hid in the brain itself.

The following conclusions are drawn:—

(1) Insanity is an emotional state. It follows the same laws as other positive emotions follow.

(II) Heat and loss of sleep exite it.

(III) Walking in the garden, *i.e*, changing the situation did not produce any positive result.

(IV) There was no appreciable effect found in him by sleep.

(V) Different capacities are disturbed in different degrees.

42. Social Psychology and Industry.

S. C. SINHA, Calcutta.

The role of industrial psychology. Failure in our country. Change in political situation. Nation Building and national industry. Industrial reference. Increased output necessary. Depends not only on improved machinery but also on labour personnel.

Vocational Selection—not sufficient, Healthy social life of labour personnels essential. Cause of conflicts outside managements. Necessity of psychological research and handling in the social life of labourers. Social organisation centres. Bureau to train, guide and help in practical and effective way. How to conduct them on proper line. What to know.

Social security. Suggestion regarding duties and organisations of social study centres of the labour personnel. Immediate necessity and co-operation between scientists and Government.

SECTION OF GEOLOGY AND GEOGRAPHY

PRESIDENT : P. K. GHOSH, M.Sc., Ph.D., D.Sc., D.I.C., F.N.I.

A. Geology

1. The petrology of 48 flows of Deccan Trap in Eastern Kathiawar and its bearing on the differerentiation of basaltic magma.

W. D. WEST, Calcutta.

The 48 flows, which were penetrated by deep borings, can be divided into three groups : (i) flows of porphyritic basalt resembling the normal Deccan Trap type; (ii) flows with phenocrysts of olivine, pyroxene and bytownite-anorthite; and (iii) flows with phenocrysts of olivine and pyroxene, which can be designated oceanite, ankaramite and limburgite. The three types are interbedded, and the appropriate magmas must have been available for extrusion throughout the period of volcanic activity.

In view of the fact that the normal type of Deccan Trap basalt is remarkably uniform in chemical composition (belonging to Kennedy's tholeiitic magma type), it is tempting to regard it as 'parental', and to infer that other rock types associated with it have in some way been derived from it. The purpose of this paper is to describe some of these other types, and to consider how they may have been derived.

A study of the optical characters and chemical composition of the constituent minerals shows that the *olivine* phenocrysts vary in compositiom from a variety with about 40% or more fayalite in group (i), through a variety with about 20% fayalite in group (ii), to a highly magnesian variety in group (iii). The pyroxene phenocrysts are diopsidic-augite in groups (ii) and (iii), while the groundmass pyroxenes in group (i) are pigeonitic-augite. The *felspar* phenocrysts are labradorite in group (i), and bytownite-anorthite in group (ii). Twelve new complete rock analyses have been made, while the pyroxene and olivine phenocrysts have also been analysed. These data show that the composition of the phenocrysts is closely related to the composition of the rocks in which they occur.

As regards the origin of these rock types, it might be suggested that the ultrabasic types have been derived from the normal Deccan Trap basalt magma by the sinking of the olivine and pyroxene, and perhaps felspar phenocrysts that occur in it. But the fact that the olivines of the ultra-basic types are more magnesian than the olivines of the normal Deccan Trap basalts, the pyroxenes richer in lime and poorer in iron, and the felspars more calcic, suggests that this has not been the immediate mode of origin.

A second possibility is that long prior to the time of the Deccan Trap eruption the original basalt had already undergone differentiation locally by the sinking of early formed crystals, and that the magmas then froze. Later, when remelting took place magmas of varied composition would be available, and the early formed crystals in the ultrabasic portions would be magnesian olivines, diopsidic pyroxenes and calcic plagioclases.

A third possibility is that the parental magma of the Deccan Traps was more basic than the common Deccan Trap basalt, and that the early formed olivines, pyroxenes, and perhaps felspars, of basic composition, had already sunk prior to the extrusion of the Deccan Trap basalts, and that it was only in certain areas on the west side of India that the magma containing the sunken crystals was also extruded. On this hypothesis the parental magma may have had the composition of the 'olivine- basalt' magma type of Kennedy, giving rise on differentiation to the 'tholeiitic' magma type (the normal Deccan Trap basalt) plus the ultrabasic rocks.

The second hypothesis seems likely to be nearest the truth.

2. Petro-Chemistry and petrogenesis of the outliers of Deccan Trap of the Godavari District.

E. VENKAYYA, Waltair (Communicated by C. MAHADEVAN)

The Deccan Traps of Pangidi and Kateru were studied both in the field and in the laboratory. The geological formations mapped include the Tripati sandstones, Infra-trappeans, Deccan Traps with one inter-trappean limestone band, and Tertiary sandstones with the Godavari alluvium. Attention is drawn to the conflicting nature of the evidence advanced by the earlier works on the age of the Infra-trappeans. Two distinct flows have been identified while the presence of a third flow is surmised. The traps consist of basic labradorite, pigeonite, and iron ores with subordinate amounts of glass and are similar in compositiom to those of the Central Provinces and other plateau basalts. Niggli diagrams of the analyses show a calc-alkaline trend of differentiation. It is deduced that the traps are derived from a picritic magma which explains the high content of iron and titanium and their high super heat and fluidity. The author concludes that this outlier separated by a distance of 250 miles from the nearest present margin of the main traps was a centre of independent eruptivity in the lower trappean period.

3. A note on the Lingadhalli traps from Chikmagalur District, Mysore State.

C. S. PICHAMUTHU, Bangalore.

A large area in the Chikmagalur District to the east of the Bababudan Hills is composed of basic rocks which have been described by earlier workers under various names—such as traps, hornblendic lava, hornblende schist etc. In papers presented to this section of the Indian Science Congress (1932, 1933) and published in the Quarterly Journal of the Geological, Mining and Metallurgical Society of India (1932,1935), the spots and patches occurring in these rocks were described in detail by the writer, and the conclusion was arrived at that they were metamorphosed amygdales, in some of which plagioclase feldspars were developed.

This paper gives the petrographical and chemical characters of these rocks, and the relation they bear to some of the well known traps occurring in India as well as in other parts of the world.

4. Olivine Norite dyke, Coonoor, Nilgiris.

T. N. MUTHUSWAMI, Madras.

The paper gives a full description of the olivine norite dyke—Coonoor-Nilgiris, described by Sir Thomas Holland in the Records, Geological survey of India, Vol. XXX, 1897. The plagioclase is computed to be $Ab_{32}An_{68}$ from the universal stage measurements of the Albite-Carlsbad complex type of twinning. The rhombic pyroxene is identified to be enstatite with mixtures of hypersthene and the inclined exinction noted is determined to be with reference to a pyramidal cleavage.

The monoclinic pyroxene is considered to be a ferro-augite from its 2 V readings and not pigeonite. The mineral shows diopsidic lamellae. The olivine is characterised by a smoky brown colour with excellent reaction borders. The chemical analysis is given. The C.I.P.W. norm, the Niggli values and the Kata norm have been worked out and the rock is referred to the normal gabbro theralite magma type of Niggli.

5. The Charnockites of Kondapalle (Kistna District).

B. R. CHELUVA IYENGAR, Bangalore.

Detailed field and petrographic study of the Charnockite series of Kondapalle reveal the development of all the four, the acid, intermediate, basic and ultrabasic types in Kondapalle. They are, however, best developed at Ibrahimpatnam, three miles due south of Kondapalle. Two types of hypersthene, differing in pleochroism, (i) x=clear pink, y=yellow, z=bottle green and (ii) x=pink, y=brown, z=green, have been separated and chemically analysed and the peculiar pleochroism of the second type is found to be due to the low iron content. As regards the origin of the Charnockites of Kondapalle the detailed petrography, the complete chemical analyses of representative rock types and a detailed heavy mineral analysis, point towards an igneous origin, later subjected to plutonic metamorphism.

6. Geology and petrology of Pachipenta Zamindari, Vizagapatam District, Madras.

G. Gopalakrishnasastri, Waltair. (Communicated by C. Mahadevan)

The author carried out a detailed study of the geological formations exposed in the Pachipenta Zamindari in Vizagapatam District. A geological map of the area was prepared and the sequence of the various members of the Khondalite series—the country rocks in the area—was established. An optically positive cordierite has been subjected to chemical analysis and the anomalous positive nature is attributed to the low Feo-content. Three members of the Khondalite series have been chemically studied. The most extensive rock type, the biotite-gneiss, is considered to be the metamorphosed representative of an argillaceous sandstone. The parent rock of the garnetiferous gneiss is concluded to be an argillaceous sediment slightly poor in alumina. A dolomitic sandstone is supposed to have given rise, on metamorphism, to the diopside-quartzite. Evidences have been given to show that the metamorphism that gave rise to the Khondalites is thermal. Chemical analysis of an augite-norite, representing the Charnockites in the area, has been carried out. Based on petrochemical studies, textural features and field relationships, the Charnockites are concluded to be of igneous origin and intrusive into the Khondalites. The occurrences of some associated economic minerals like mica, graphite and crystalline limestone have also been studied.

7. Geology and petrology of the Kailasa Hill-range.

Ch. Narasimharao, Waltair. (Communicated by C. Mahadevan)

The rock formations of the Kailasa hill-range and environs in the vicinity of Waltair were studied in detail, in the field and in the laboratory. The physiographic features of these are portrayed elaborately. Vast expanses of the country to the north and the south are covered by red loamy soils and blown sands. The metamorphic rocks, viz., the Khondalites which are sillimanite-garnet-graphite-felspar-quartz-gneisses form the country rock. Charnockites, acidic, as well as basic occur as sills, and bear intrusive relationship towards the para-gneisses. Analytical and field data reveal that Khondalites are highly metamorphosed arenaceous sediments with argillaceous, carbonaceous and ferruginous impurities. It is suggested that granites are formed due to felspathisation and recrystallisation of Khondalites consequent upon the intrusion of Charanockites. Leptynites are supposed to be the products of recrystallisation of Khondalites in the vicinity of Charnockites. Economically the area is not of great importance. Except for building stones and graphite, occurring in a few lenses and pockets in the proximity of pegmatites there are no other valuable mineral deposits.

8. Khondalite-Charnockite association in Palamau District, Bihar.

K. P. Rode, Dalmianagar.

The author while studying the geology of the region immediately to the south and south-east of Daltonganj, came across a number of rock types which show unmistakable affinities with the Khondalite series of the Eastern Ghats. These include graphite schists with or without garnet, sillimanite, cordierite, biotite, and calcitic and dolomitic marbles, calc-silicate rocks, magnetite bodies, quartzites and leptynites.

These are found associated with basic dykes and granodiorites and granites showing variable development of hypersthene. The mineral and textural peculiarities strongly suggest their resemblance to the Charnockite series.

All the above rock types are further traversed by veins and dykes of pegmatites and aplites.

The field relations as well as microscopic studies have shown that Khondalite-Charnockite association is only incidental and that the former has not played any significant part in the formation of the latter as visualized by Ghosh and others, though a few cases have been found where the Khondalitic gneisses have hypersthene as one of their occasional constituents.

9. A note on the Epidiorite Sill of Ramgarh Area, District Naini Tal, U.P.

I. C. Pande, Benares.

In this paper the discovery of a sill of epidiorite (as per definition of von Gumbel) in the Ramgarh area (29°26′ : 79°41′) in the year 1940 and on subsequent mapping

in 1943, 1944, and 1945 of the adjoining areas and the important results of regional metamorphism as revealed by the internal constituents of the sill rock are recorded.

The sill is very well exposed on the road cutting at 18½ miles on the Ramrgh Nathuakhan road, and at the 9th milestone on Bhim Tal-Mukteswar road, near Buransi. The sill is 60—80 ft thick and more than 8 miles long. It runs in a N.N.W.-S.S.E. direction.

The microscopic examination of these rocks shows that there have been extensive mineralogical changes accompanied by structural deformations during uralitisation, saussuritisation, biotitisation and chloritisation.

The rocks that compose the sill are :—

1. augite-clinozoisite-plagioclase-amphibolite (Sp. No. 1/81) ;
2. chlorite-biotite-clinozoisite-albite-amphibolite (Sp. No. 1/72) ;
3. calc-biotite-chlorite-epidote-albite-hornblende-schistose-gneiss (Sp. No. 1/34 & T/100) ;
4. biotite-chlotite-albite-clinozoisite-schistose-gneiss (Sp. No. M/18) ;
5. biotite-chlorite-clinozoisite-hornblende-schist (Sp. No. 1/85 & T/101) ;
6. quartz-diorite (Sp. No. 1/71) which is found at the contact of the sill with the quartz-porphyries of the area.

An endeavour has been made to trace the retrogressive changes that took place in the sill after the consolidation of the basic magma. The effect of later intrusion on the quartz-porphyries is the formation of quartz-diorite.

It is interesting to note that a complete transition, from sub-blastophitic amphibolite (Sp. No. 1/81½) through the massive amphibolite (Sp. No. 1/72) and schistose-gneiss (Sp. Nos. 1/34, T/100 and M/18) to the schist (Sp. Nos. 1/85 and T/101) is exhibited by this small sill.

The area has been subjected to intense folding and imbrication. The low angle fault, that runs from Malwa Tal, passing through 7191 ft. Kulethi peak, the 7th. milestone on Ramgarh-Ratighat road, the 33rd. mile-stone on the Almora cart road near Garampani and then extending to Majhera, is a thrust fault, named Ramgarh thrust by the writer.

(The numbers relate to specimens in the author's collection).

10. Xenoliths of Schorl-rock in Granites of Sini, Singhbhum, Dist. Bihar.

R. C. SINHA, Benares.

The paper deals with the origin and detailed microscopic and chemical study of the schorl inclusions in the granites occurring at a distance of half a mile on the south of Sini Railway Station, and the age and origin of the parent rock.

The field work was done during the summer months of 1947 and an area of 24 sq. miles surrounding Sini was mapped on a scale of 1″=1 mile.

The peculiarity found in the granites is that they contain xenoliths of schorl varying in size from a fraction of an inch to 9 or 10 inches in diameter. These inclusions are found to be more frequent and larger in size near the doleritic dykes which tra. verse these granites. The contact rock contains quartz, felspars (mostly microperthite)e schorl, ilmenite, titanite, biotite, apatite and titaniferous magnetite. The most inter, esting feature found in these rocks is the frequent occurrence of zonal arrangemeut o. minerals with ilmenite or titaniferous magnetite at the core, surrounded by titanitf then apatite and lastly biotite at the extreme periphery.

11. Hybrid-gneisses in Bundelkhand granite, Mahoba, Hamirpur District, United Provinces.

R. C. MISRA, Lucknow.

Besides large exposures of simple granites of various varieties, epidotised granites, and gneisses have been observed in the area. The gneisses for various reasons, based on field relationship, optical and chemical characters appear to be of the composite type. All gradations from granite-gneiss with a few unassimilated black patches to banded gneiss definitely of hybrid nature are seen.

The banded gneisses owe their origin to the granitisation of rocks which may be hornblende-biotite-schists, though the unattacked host rock has not been so far seen in the field. On this account the Bundelkhand granites are assumed to be intrusive into the pre-existing older rocks.

12. Age of the Saline Series in the Salt Range of the Punjab.

A. K. Ghosh, J. Sen, *and* A. Bose, Calcutta.

The age of the Punjab Saline Series is still a vexed problem in Indian Geology. E. R. Gee to whom we are indebted for much of our geological knowledge of this area has assigned 'Cambrian' or 'pre-Cambrian' age to the series. B. Sahni, on the other hand, from the evidence of microfossils e.g., woods of conifers, cuticles of grasses, angiospermous wood elements etc., and their repeated occurrence at widely different localities has assigned an Eocene or later age to the Saline Series. The latter according to some geologists is irreconcilable with the field evidence, and they were unable to offer any explanation for the presence of microfossils, stated above.

In view of this great interest in the subject, the authors obtained from Dr. Gee, for analysis, the following rock samples belonging to the Punjab Saline Series and from strata overlying and underlying the series :

(a) *Vindhyans*—G. 1. (Bijaigarh shales) ; G. 3-5 (Bituminous dolomite from bore holes at Nagpur, Jodhpur state, Rajputana).

(b) *Punjab Saline Series*—57/264 ; 57/267 ; 57/270-71 ; 57/280 from the upper and lower gypsum stages at Dandot, Makrach, Khewra and Warcha.

(c) *Purple Sandstone*—from North of Chenki, Jabbi, Salt Range.

(d) *Neobolus shales*—k33/591 (b & d) from Kusal fort.

(e) *Magnesian Sandstone*—6292 from eastern part of Salt Range.

(f) *Salt Pseudomorph beds*—57/285 (sandstone) and G. 2 (dolomite) from Chittidil ; 4977 from Ratucha, Jhelum district.

Of these, samples bearing Nos. G. 1., G. 3-5, and 57/271, yielded no microfossils, following the maceration technique and usual sectioning. Every precaution was taken to prevent any contamination.

The microfossils recovered from (b) confirm the findings of Sahni and his collabo rators. But the real interest in our work is the recovery of (i) few multiseriate bordered pits and a cuticle, probably of gymnospermous affinity from (c) but not recorded by Hsü (See *Proc : Nat* Acad : Sc : B. 16(2—4), 92, 1946) ; (ii) numerous pieces of wood often with uni—to multiseriate bordered pits and a round pitted spore with triradiate scar from (d) ; uni—to multiseriate bordered pits on carbonized pieces of wood from (e) ; and wood elements, cuticles and spores of pteridophytic, gymnospermous, and angiospermous affinity from (f) but not confirmed by Lakhanpal and Bhardwaj, *in literis* (Sahni).

Further work is in progress with samples obtained from Prof. Sahni and others. The microfossils recovered so far are few in number in proportion to the large number of preparations examined. From the data in hand i.e., the occurrence of microfossils in beds overlying the Saline Series and of undisputed age (stated above), it is imperative that further extensive work be carried out, for confirmation of the conclusion drawn by Sahni on the age of the series in question.

13. Some Zoo-geographical features of the Mirzapur Vindhyas as evidenced by the distribution of fishes.

Sundar Lal Hora, Benares.

Two collections of fishes made in the Mirzapur District, U.P., by the Zoological Survey of India are listed and zoo-geographical notes are given regarding the present-day distribution of *GlyptBoroax horai*, *G.annandalei*, *Tor kaudree*, *Labeo bolgut*, *Garra mullya* and *Puntius amphibius*. The distribution of these fishes supports the hypothesis advanced by the writer several years ago that the Satpuras up to fairly recent times must have formed a continuous high range of mountains connecting the Assam Himalaya on the one hand and the Western Ghats on the other. The fishes listed above represent remnants of five waves of migration which became locked up in the northernmost spurs of these mountains. These waves of migration probably occurred in comparatively recent times and at that period the Ganges and the Son were non-existent in their present form.

14. A new Inter-trappean Charophyte.

Sripad Rao Kilpady, Nagpur.

The Charophyta reported from the Inter-trappeans of Hyderabad hitherto, have proved to be very similar to the forms described in recent years from the Nagpur and

Rajahmundry areas. This paper describes an Inter-trappean charophyte from the Gurumutkal area, Yadgir *taluq*, Gulburga district which is very different and distinct from those hitherto described from India.

The 'fruit' (oogonium) is very small, slightly vasiform in shape with a rather flat apex and obtusely tapering base. The length is 670 *u* and breadth 450 *u* and the width of the cells at the equator is about 70 *u*. The equatorial angle is 20°. The number of whorls is 10 and the cells are concave on account of incomplete calcification.' This form is apparently different from those hitherto described from the Rajahmundry and Nagpur Inter-trappeans.

15. Fossiliferous limestone from near Bhagwi, Jind State, Punjab.

N. N. CHATTERJEE, Calcutta.

The paper gives an account of a fossiliferous limestone bed occurring near the village Bhagwi (28°37' : 76°22') in Jind State, Punjab. The limestone is supplied to the Dadri Factory (28°36' : 76°16') for the manufacture of Portland Cement. The specimens were collected by the author with the kind permission of the Cement Company. The limestone bed occurs at a depth of 2 or 3 feet below the soil. The colour of the limestone is milk white to dirty white or grey and is sometimes slightly buff. The limestone does not seem to be very compact or hard. The quality of the limestone is quite good having the following composition:

Insolubles	2·5%
Fe_2O_3	1·5%
Al_2O_3	0·3%
CaO	51·6%
MgO	1·3%

The limestone is highly fossiliferous and is full of gastropod shells. The gastropods on examination appear to have modern form and fresh water habits. A preliminary examination of the fossils shows the presence of the following genera: Dissostoma; Vivipara; Diastoma; Gibbula; Planorbis; Loptothyra; Radix; and Lymnaea.

The fresh water habit and the modern form of the fossils point to the existence of fresh water basins in which the several families of gastropod flourished and the bed of limestone was formed out of these animal remains. The age of the bed appears to be sub-recent. The author acknowledges the help received from Mr. P.N.Mukerji of the Geological Survey of India in the matter of fossil identification.

16. On the Nature and Probable Age of the Bor Hill Volcanics.

M. R. SAHNI, Calcutta.

Blanford recorded trap representing the Deccan Trap formation, from two distinct horizons in the Bor Hill in the Laki Range in Sind, viz, (1) The Upper trap, being an amygdular flow resting on the Olive shales (*Cardita beaumonti* horizon which is generally accepted as of Danian age, although doubts have been expressed by others in this respect and a somewhat younger age ascribed to the horizon), (2) the lower fairly thick bed of trap which occurs in the sandstone underlying the *Cardita beaumonti* horizon. The sandstone is unfossiliferous, but owing to its lithological resemblance to the Pab sandstone of Beluchistan, and its stratigraphical position below the *Cardita beaumonti* horizon, it is generally assigned to the Cretaceous. On account of the non-amygdaloidal character, the trap may be regarded as possibly of intrusive origin and later than the sandstone. The author has however traced at different horizons in these sandstones in the Bor and the adjoining Barrah hill several outcrops of an amygdular trap which he regards as contemporaneous flows interbedded with the sandstone. The fact is significant in fixing the lower limit of the age of the traps.

In the present state of knowledge the uppermost flow, viz., that overlying the *Cardita beaumonti* horizon is assigned to the post-Danian while the lower flows in the underlying sandstone to the Cretaceous age, although it must be admitted that the age of the sandstone has been deduced only from indirect evidence. Should however the *Cardita beaumonti* beds ultimately prove to be younger than Danian and an examination of microfossils and heavy minerals fail to confirm a Cretaceous age for the underlying sandstone, the possibilities should not be ruled out of the whole sequence being of Lower Tertiary age.

17. The Correlation of the Bijawars and Gwaliors with Delhis based upon the study of Igneous activity at Bayana in Bharatpur State.

V. S. DUBEY and B. D. PATHAK, Benares.

Recently the writers while carrying out the geological survey of the Bharatpur State studied the basic lavas occurring in the Alwar Series near Bayana in the Delhi System. The character of those lavas and the degree of the metamorphism, and the nature of the associated rock clearly resemble those of the basic lavas occurring near Ranthembhor which is about fifty miles from this area . The lavas of Ranthembhor are clearly known to belong to the Gwalior Series and are exactly similar to those found near Gwalior town. From this correlation it is clear that the lavas of the Delhis and the Gwaliors are of the same age. This clearly strengthens the view that the Delhis and the Bijawars are of the same age, and that the Delhis of Bayana consisting of quartzites may be contemporaneous with the Par quartzites of the Gwalior and other quartzites of the Bijawar series.

18. A Contribution to the Stratigraphical Position of the Dharwar Rocks, Singhbhum District, Bihar.

R. C. SINHA, Benares.

The paper deals with the stratigraphical position of the Dharwar rocks of Singhbhum District (Bihar). The conclusions are derived mainly from field observations and detailed mapping done by the writer during the summer months of 1947, in the area surrounding Sini in that district. Dunn (Mem. G.S.I., LIV, 1929, p. 11) has discussed the order of superposition of the rocks of Nothern Singhbhum, but the present writer is not in full accord with Dunn's conclusions especially in the light of the observations made by him on this area. After a detailed discussion of the various views of Dunn (op. cit.) and Jones (Rec. G.S.I., LIV pt. 2 p. 207) together with those of others, the writer gives his own conclusions as regards the stratigraphical position of these rocks which is as follows :—

Lower Cuddapah	Nower Dolerite
Dharwars	Granites and aplites Schists bearing copper lore Ultrabasic rocks Phyllites and chlorite schists Kyanite schists and schists bearing staurolite crystals together with quartzites and conglomerates. Mica and hornblende schists (mainly horblende). Base not seen

Further the view held by several of the previous authors that the Dharwars are entirly of igneous origin , the hornblende and chlorite schists being representatives of altered basic igneous rocks and that no transition from phyllites to schists are found, has been contradicted. Very clear transitions from phyllites to mica schists and thence to chlorite schist have been found and thereby the undoubted sedimentary nature of Dharwars, at least in this area has been observed in detail.

19. The Geology and Stratigraphy of Jhura Hills, Cutch State.

S. K. AGRAWAL, Benares.

The paper gives an account of the geology and stratigraphy of the Jhura Hill, N.W. of Bhuj, in the Cutch State. Detailed mapping of the area on a scale 4″=1 mile, was done in the winter months of 1946 for the first time under the guidance of Prof. Raj Nath. The rocks occur in the form of a dome and hence show radial dips. The dip values are high to the north and gentle to the south. The rocks are further affected by faults and igneous intrusions in the area. The rocks consist of shales and various types of sandstones belonging to Chari Series and the lowest bed is probably of Patcham Series. They have been subdivided into 18 divisions on lithological characters in the field and fossil collections were separately made from each. The fossil collection consists mostly of ammonites, brachiopods, lamellibranchs, along with gastropods, echinoids, corals and fossil plants. The fossils are at present under investigation by the writer.

20. The Geology of the Habo Hills, Cutch.

B. S. Tiwari, Lucknow.

The paper embodies the results of detailed geological mapping of the Habo Hills between latitudes 23° 20′—23° 23′, and longitudes 69° 47′—69° 56′, during the months of October, Novermber and December, 1946. A systematic collection of rocks and fossils has been made.

The formations present in the area belong to the Chari and Patcham series. The writer has made obsrevations regarding the dome structure of the hills, which is mainly due to the large scale igneous intrusions probably connected with the Deccan Trap activity.

The paper describes the lithology and stratigraphy of the area. The fossil collections are being examined,.

21. A contribution to the Geology of the Ramgarh Area, Nainital District (U. P.)

I. C. Pande, Benares.

A survey of the geology of the Ramgarh valley (29° 26′ : 79° 41′) and of adjacent areas, revealed interesting facts concerning lithology, stratigraphy and structure, which are recorded in this paper.

The Ramgarh valley was mapped on 12″ = 1 mile scale in the summer and autumn months of 1940, summer of 1943, autumn of 1943, summer of 1945 and spring of 1946. The part mapped is bounded by latitudes 29° 23′ and 29° 30′ and longitudes 79° 26′ and 79° 38′.

The Ramgarh and adjacent hills belong to the Gagar Range of Kumaon and form the outer part of Nag Tibba Range of the Lesser Himalayas. The geological column includes a complex series of quartzites, grit, various schists (quartz-muscovite, muscovite chlorite, and hornblende) and sheeny schistose phyllites (chlorite-sericite, sericite-chlorite, and talc).

The schistose phyllites were intruded by acid rocks (quartz-porphyries) and migmatised to gneissose quartz-porphyries. At a later stage the quartz-porphyries were intruded by an epidiorite sill which has given rise to quartz-diorite near its contact.

The metamorphic series of the present area has been correlated with the "Inner Schistose Series " of the Himalayas which again on the basis of lithological and stratigraphical evidence is here considered to be of Jaunsar age. The rocks are devoid of fossils and hence the age assigned cannot be regarded as final at the present stage.

22. Asbestos in Nikumbh area, Gwalior State.

K. V. Krishnamurthy Rao, Gwalior.

Asbestos , both of the crossfibre and slipfibre types is found two furlongs west of Nikumbh (Jagir Village) in the Neemuch Paragana, Mandsaur Dristirct. It is fourteen miles west of Nimbahera Ry. Stn. on the Ajmer-Ratlam section of B.B.& C.I.Ry. It is of the amphibole variety and found in association with quartz at the contact of veins of quartz in hornblendic trap. Contact effects are clearly visible in qaurtz. Serpentinisation in trap is abundant. The trap is highly calcareous and is in contact with the Aravalli slates and shales in the type area. Similar serpentinisation in trap has also been noted a few yards north of Padlia (Gwalior), six miles south of Nikumbh. The trap stretches south from Nikumbh for nearly eight miles and is on the average about a mile wide.

The mineral is white and soft. The veins are from 0.2′ to two inches in width. Fibres have no tensile strength and break. The occurrence may be similar to that of Bundi (Coulson, Asbestos Memoir).

Since the intervening stretches between Nikumbh and Padlia lie in Mewar and Tonk States, a full examination of the trappean area could not be done. Since the area covered by the traps is by no means negligible, it is suggested that a thorough examination of the area may be taken up.

23. Bauxite Deposits of Amarkantak Plateau, Rewa State, Central India.

B. S. Tiwari, Lucknow.

A survey of bauxite deposits of this region was carried out in January 1946 and the main observations obtained in the field and laboratory are summarised in the present paper.

The best ore containing 60-65% alumina occurs along the periphery of the plateau.
Ores containing less alumina are scattered at various places all over the plateau.
The area has been geologically mapped by the author.
The most economical way of exploiting the ore is suggested in this paper.

24. The Chromite Deposits of Kondapalli, (Kistna District).

B. R. Cheluva Iyengar, Bangalore.

The chromite deposits of Konadapalle are situated in an area (16°37′ : 80°32½′), about 10 miles to the N.W. of Bezwada. The geological features of the area comprise, the Bezwada gneisses, the granitic gneisses and the Charnockites, and the chromite deposits are restricted to the ultrabasic Charnockites, mainly the pyroxenites (Enstatite-hypersthene rock). The occurrence of the ore is chiefly in the form of pockets or lenses in disseminated patches and often in regular and perfect bands. No olivine has been found but the serpentine noticed in certain places is due to the alteration of pyroxene. Six complete chemical analyses of representative chromite ores from the area show that the value of the Cr_2O_3 of the ore ranges from 36 to 55 per cent. The detailed field and petrographic studies indicate that the chromite of Kondapalle is magmatic in origin, the ore crystallising as the first mineral and later joining with the orthopyroxene.

25. X-Ray study of some Indian Coals.

N. N. Chatterjee *and* N. N. Gupta, Calcutta.

The authors have given an account of X-ray photographs(X-radiographs) of the following samples : (*i*) Seam No. V, New Gobindapur colliery, Jharia ; (*ii*) Seam No.V, North Bhuggatdih colliery, Jharia ; (*iii*) Seam No.IX Dhansar colliery, Jharia ; (*iv*) Seam No.X Rajapur colliery, Jharia (*v*) Seam No.XIII North Damuda colliery, Jhaira (*vi*) Nega seam , Raniganj coalfield all belonging to the banded bituminous type ; (*vii*) Palana lignite from Bikaner ; (*viii*) Watching bright coal from upper Assam ; (*ix*) Jammu anthracitic coal from Kashmir. (*i*) to (*v*) of Barakar age ; (*vi*) of Raniganj age (*vii*) to (*ix*) of Eocene age.

X-rays were allowed to fall on thin slices(1-1.5 mm thick)of coal cut at right angles to the bedding planes. The work was carried out in the Laboratory of the Indian Association for the Cultivation of Science, Calcutta with kind permission of Prof. K. Banerji and the X-radiographs were taken with the help of Mr. N. N. Gupta. In these experiments Hadding- Seighbahn x-ray tube with aluminuim cathode and copper target was used.

The X-ray photographs show clearly the difference in the amount of absorption of X-rays by the vitrain and durain bands.Vitrain or bright band appears transparent as it has the minimum absorption.

The arrangement and distribution of the mineral matter and its grain size have been faithfully brought out in the photographs of the lower Gondwana bituminous coals. The mineral particles are present in these cases mostly in very minute size (less than 0.1mm) and they are found to be irregularly distributed. Few bigger praticles are also present, the maximum size being 0.5-1 mm. The Eocene coal specimens contain insignificant amounts of mineral particles showing more or less the purity of the coal substance. The ash of the Tertiary (Eocene) coals varies between 0.5-12% and that of the Lower Gondwana coals between 10-30%.

The very minute size of the mineral particles as represented in these photographs tends to show that it would be rather impossible to remove these particles of inorganic matter by any method of washing unless the coal is ground down to that fineness which however does not seem to be a practical proposition.

26. Diamondiferous plug in Panna State, C.I.

V. S. Dubey *and* Sukumar Merh, Benares.

Diamonds are known to occur in Rewa Conglomerates in Panna State but the exact source from which they are derived was not known. Recent work has located a diamondiferous plug covering an area of about 2,00,000 sq. ft. The rock is ultrabasic in

nature, similar to Kimberlite of S. Africa. It is post-Bijawar and belongs to the Gwalior Trap igneous cycle. The Gwalior or Bijawar trap was followed by these diamondiferous ultrabasic rock intrusions followed by granite. The diamond content on an average is onecarat per four tons of rock which is similar in magnitude to that found in the Kinberley mines. The diamonds are of quite high quality and are upto 40 to 50 carats in weight. The plug probably goes very deep, and at the rate of four tons per carat, the diamonds in the upper 3000 feet are about 5 lakh carats in wieght and Rs. 50 crores in value. The deposit is commercially workable. Petrological, geological and stratigarphic details about the plug have been given in the paper and its commercial utilisation has been discussed.

27. Iron-ore deposits of Mandi State.

V. S. DUBEY *and* SATISH CHANDRA GUPTA, Benares.

In a paper published in the Quarterly Journal of the Geological Mining and Metallurgical Society of India in 1930 Dr. S. K. Roy suggested that there are big deposits of iron ore in Mandi State. The writers realise the possibility of the development of the iron and steel industry from the ore deposits by the electro-smelting process, now so well practised in Norway and Sweden, as cheap Hydro-electric power is available at Joginderhagar, Mandi State and more power can be developed at cheap rates.

The possibility of this development, so much needed in the northern zone of India, induced the writers to take up the investigations of the raw materials and power resources as well as the question of cost.

The availability of iron ores, charcoal and limestone has been considered and the possibility of generating hydel energy has also been investigated. As a result of this investigation the writers are satisfied about the cost of raw materials and the power, but the results of their investigations to date do not confirm Roy's estimate of the quantity of iron ore.

According to the writers' estimates, the ore exposed at the surface is of the order of 100,000 tons and it is only by magnetic surveying and drilling that one would be able to state whether or not large quantities of the ore such as are visualised by Roy are present underground.

Further they are unable to confirm Roy's observations that (1) the ore-body extends to a great distance in the N-W. direction along the Charayan dhar, and (2) the Charyan dhar deposit extends up to Sandalwara area.

The above remarks are based on about two months' field-work which is however being continued to examine further evidence, if any, of the possiblity of the occurrence of an extensive deposit of iron ore. Should a sufficient quantity of ore exist, it would be possible to develop a steel plant of 100-ton capacity in the area.

28. Suitability of limestones for making Pig and cement from Indian Iron Ores.

R. GHOSH *and* R. K. DUTTA ROY, Calcutta.

Indian iron ores are exceptionally pure and as such permit the use of inferior grades of limestone than hitherto practised inspite of the fact that Indian cokes are invariably rich in ash-content. The slag, a byo-product in the iron industry, produced by the use of such inferior quality of limestone will be available for the manufacture of cement.

29. On the origin of laterites from Deccan Traps of Vikarabad area, Hyderabad State.

G. VENKATESWARA RAO, Waltair. (Commmnicated by C. MAHADEVAN)

Laterites which cap the Deccan Traps 'in situ' in Vikarabad area in Hyderabad State are slightly more siliceous than those in other areas. Lateritisation is effected through the zones of kaolinised trap, lithomarge and variagated clayey layer. The silicates in the parent rock are acted upon by carbonated waters during the wet season converting them into carbonates which are oxidised later on to oxides. These are concentrated during the dry season when, due to capillarity, an electrokinetic charge is developed in the colloidal state of decomposed materials. The migration of the electrically charged particles and their concentration depend upon the sign of the electricity produced and the valency of the radical. Further alumina is at its maximum as is seen from analytical data just above the zone of lithomarge and at the bottom of the variagated clayey layer. This acts as a semi-permeable membrane which allows only selected

colloid particles upwards. A phenomenon of cataphoresis occurs producing chemical separation. The concentration is aided by the nature and behavior of 'sols' which are the immediate products of decomposition. The 'sols' of higher valency elements are converted permanently to 'gels' in the presence of an electrolyte which settle down but those of lower valency are reconverted to 'sols'.

30. Common Salt deposits of Bharatpur State.

V. S. DUBEY *and* B. D. PATHAK, Benares.

More than a century ago salt was manufactured extensively in Bharatpur State. The production was quite large. This was stopped when salt became government monopoly. There are a large number of big wells which contain highly saline water. This water was evaporated in the sun to get salt. A detailed study shows that there is a belt which contains highly saline underground water in the Bharatpur State, the salinity not being confined to the surface but being connected with underground geological factors. The view of the writers is that there is a saline belt in this area similar to Sambhar area. Large amount of salt solution can be obtained which on evaporation will yield good salt. A pumping of twenty-five thousand gallons per hour which is quite practicable will produce about 25000 to 30000 tons of salt per annum. Hence the capacity from this source can easily be about 30,000 tons in a year. It can become important due to the passing of the well-known Khewra deposits of the Salt Range to Pakistan.

31. Some Economic Minerals from Dewarkhand and neighbouring area (Chota Nagpur).

R. S. MITHAL, Benares.

The paper deals with the economic aspects of some minerals collected from Dewarkhand and neighbouring areas of the Chota Nagpur Raj.

The coal in particular and limestone deposits worked at Ray, Karkata etc., have previously been referred to by A. Jewett (Mem. G.S.I. LII Part I—1925). The other economic minerals and rocks recorded by the present author for the first time are :—

1. Mica at Chama (23°35′ : 85°1′)
2. Felspar at Aktan (23°37′ : 85°7′) Ichapeeri (23°37′ : 85°14′) Arid (23°37′ : 85°10′)
3. Quartz at Hoyer, Aktan, Ichapeeri and Sarle
4. China Clay at Sarle (23°28′ : 85°6′) Babhne (23°39′ : 85°5′)
5. Fire Clay at Ray (23°46′ : 85°4′)
6. Quartzite at Mankitand (23°39′ : 85°1′), Hoyer and on the way from Babhne to village Sarle.

The mode of occurrence, extent, the economic utility etc. of the newly recorded minerals are discussed in this paper. These minerals are of good quality. They are economically workable as they occur in considerable quantities and in fairly easily accessible localities.

Mica, quartz, felspar, china clay and fire clay are suitable for usual purposes and the quartzites can easily be used for the manufacture of glass.

32. The Peridotite rocks of Manpur, Dhalbhum Subdivision of the Singbhum District and the Origin of the associated Asbestos Deposits.

S. C. CHATTERJEE, Patna.

The peridotite rocks form irregular dkes and inclined sheets intruded into the Singbhum Granite and the phyllites and schists of the Iron-ore Series. They consist of hypersthene with clear pleochroism from pink to green, olivine with its alteration products, and magnetite which is both secondary and primary. The paper gives detailed petrographical description of the different types of rocks and their constituent minerals, The granite rocks are more basic in this area than the typical Singbhum Granite and are altered into chlorite-bearing schists.

The asbestos veins consist of unusually long fibres of chrysotile and are derived from the olivine. Field and microscopic evidence indicates that the serpentinisation of the ultrabasic rocks was not due to the influence of hydrothermal solutions from younger acid intrusives, but an auto-metamorphic phenomenon due to the action of late-stage hypothermal solutions (hypohydrous of Hess). The transformation of

serpentine to veins of chrysotile is discussed and field and microscopic evidence is brought forward to show that the deposit can be best explained by following the replacement theory of Bateman.

33. Microscopic characters of some Copper-bearing, Metamorphic Rocks from the Khetri Mine area, Rajputana.

S. DEB, Calcutta.

Metamorphic rocks from this region containing traces of copper minerals have been examined under the microscope in thin sections and in polished sections. Carbonate minerals are usually found to occur in the secondary enrichment zone as superficial incrustation on most of these memtamorphic rocks. Sulphide minerals are found to be in a highly disseminated condition and occur only in amphiboiites and garnetiferous quartzites. The degree of metamorphism as noticed under the microscope is less intense than in the older rocks of the Aravalli Archaeans. The rocks are mostly chloritic quartzite with magnetite, garnetiferous hornblende-schist, amphibolites, tremolite-chloritic-quartz-schists, impure felspathic quartzite, and actinolite-tremolite schists.

The rocks belong to the Alwar or Ajabgarh Series of the Delhi System which occur in this part of Rajputana.

34. Fossil tortoise shell from Worli Hill, Bombay.

P. N. MUKERJEE, Calcutta.

The fossil specimen was sent to the Palaeontologist, Geological Survey of India for identification and determination of the geological horizon by Dr. S. L. Hora, Director, Zoological Survey of India. The specimen was collected by Mr. R. N. Sukheswala of Bombay. This fossil specimen was already recorded in the abstracts of the Indian Science Congress for 1946, p.97, as *Testudo Leithii*. The specific name should be *Hydraspis Leithii* Gray.

The fossil species is very closely related, if not identical with *Hydraspis Leithii* Grey (*Testudo Leithii* Carter). Several fossils of this species have already been recorded from the fresh water formation of the Bombay Island. The characters of carapace and head suggest that the genus is allied to the existing South American genus *Hydraspis*. *Hydraspis Leithii* Grey should not be confused with *Testudo Leithii* Gunther, a true land tortoise closely related to *T. marginata* of Europe.

Microscope slides, of the rock in which the fossil is embedded, show volcanic tuff material of the Deccan Trap indicating a Lower Tertiary age of the animal.

35. On some sub-fossils of the Pulicot Lake, Madras Presidency, South India.

S. S. SARKAR, Rangoon.

In 1869, William King of the Geological Survey of India collected some fossil specimens from the Pulicot Lake (18°25'-13°45' : 80°-80°17') about 32 miles N. of Madras on the east coast.

With the kind permission of the Director, Geological Survey of India, the specimens were examined and the following are the identifications :—

Mactra, Cardita, Crassina, Astarte, Tapes, Ostrea, Dosinia, Diplodonta, Venus (Omphaloclathrum cf. puerpera Linn.), Macrocallista cf. Casta Lam., Macrocallista (?) Castanea, Batissa cf. crawfurdi (Noet.) Arca pilula (Reeve), Trachycardium cf. Sindiense (Vred.) Indonaia glyptica (Prashad), Placuna placonta Lam., Dissostoma, Terebralia sublignitarum (Vred.)

The nature of deposition is a mixed one showing mostly marine, with others indicating fresh-water, estuarine or terrestrial habitat.

The general faunal assemblage suggests a Pleistocene age.

36. Mechanical Analysis of some Gondwana sandstones (South West corner of Raniganj Coalfield).

SAURINDRANATH SEN *and* SUNIL KUMAR RAYCHAUDHURI, Calcutta.

Sandstones from Raniganj, Panchet and Supra-Panchet stages, collected from Bisram *jhor* section and Panchet hill, and the Machkonda *jhor* section and Gorangi

Peak wre subjected to size-grade analysis . The samples were disaggregated carefully by keeping them under water which was in some cases slightly acidulated (HCl). After pouring off the suspended matter and the finer particles under a mild current, the dried samples were passed through I.M.M. sieves 30-200 mesh. The grains passing through 200 mesh and those decanted and elutriated off were recorded as finer than 200 mesh and plotted as of size with mean diam. between 1/16 mm to 0 mm.

Frequency polygons of 5 samples of Raniganj, 3 of Panchet and one of Supra-Panchet sandstones were prepared. It is seen from them that Raniganj samples are decidedly finer grained and one specimen 48a is a shaly sandstone while specimen 38a is calcareous. Three samples show maximum sorting with decided concentration at two size limits·0 to 0·085 and 0·16 to 0·18 mms, the other grades are either totally absent, or if present, not exceeding 5% of the total bulk. The three samples of Panchet sandstones show the maximum peaking at the coarser grade 0·42 to 0·50 mms All of them present four such peaks at 0 to 0·12, 0·16 to 0·18, 0·25 to 0·32, 0·42 to 0·50 mms. The specimen from Supra Panchet also shows four peaks at the identical size grades and the peaks are more or less equal. The following tables on Udden scale brings out these characteristics clearly. but the nature of sorting and the tendency in charge of the variables come out significantly in the Frequency polygons.

Grades in mm.	48a	38a	46a	45e	45g	53
½ to ¼mm	00·00	00·15	01·42	21·82	63·12	49·94
¼ to ⅛ mm	16·73	07·43	17·39	38·57	14·58	18·99
⅛ to1/16 mm	37·33	30·57	52·74	16·76	11·15	15·08
1/16 to 0 mm	46·94	61·85	28·45	21·84	12·15	15·99
Grades in mm	39	55	7			
½ to ¼ mm	55·72	78·57	38·23			
¼ to ⅛ mm	17·73	15·22	32·10			
⅛ to 1/16 mm	25·66	00·00	16·19			
1/16 to 0 mm	00·39	06·21	13·48			

37. Petrotectonic study in the Darjeeling Himalayas.

S. K. Ray *and* S. Sen, Calcutta.

A detailed study of progressive metamorphism of the argillaceous and associated basic and arenaceous series has recently been completed by the senior author. The specimens collected though not oriented have been subjected to minaral fabric analysis. Geotectonic interpretation of the fabric cannot be attempted seriously at this stage ; this study is a preliminary to a further detailed and systematic study.

The quartz fabric diagram in the *ac* plane of a specimen from the garnet zone (138) shows a scattering of points with little tendency to form prominent maxima. The concentration nowhere exceeds 5% and there is an absence of statistically prefered orientation. The *ac* quartz fabric diagram of another specimen from garnet zone (104) also lacks in preferred concentration or definite maxima though it shows a double girdling one on the *bc* plane and another diagonal which has a tendency to split up into an *ac* girdle. The *ac* quartz fabric of a specimen from kyanite zone (121) shows a girdling on *ac* plane round *b* which splits up into a diagonal girdle in the *ac* plane. One maxima somewhat prominent (with a maximum concentration of 7·14%) is developed betwween *b* and *c* near the maxima III of Sander's synoptic diagram.

The possible implications of the diagrams are that preferred orientation was by solid flow or dragging giving essentially monoclinic symmetry.

B. Geography

1. Need for a short term plan for the tract inside the Damodar Elbow.

S. C. Bose, Calcutta.

After the destruction of the embankment to the south and west of the river in this tract, in the inundation of 1855, it was abandoned. The embankment on the opposite side was however strengthened, raised and duplicated after every major flood disaster. In short, the river was given a free hand inside its elbow. Though it meant an annual supply of silt fertilizing these lands, the maladjustment created by the one-sided embankment slowly resulted in the gradual transformation of a belt of agricultural land into sandy barrens and savannah. Loss of standing crop, cattle, property and even obliteration of villages continued. Even now the destruction is proceeding at a rapid rate, especially where the Mohanpur Hana, a new enlarging spill channel is creating havoc every year. Thus a quick short term plan is needed to stop further rot. The Damodar Multipurpose Scheme which is still in the embryo may take five years or more to give relief to this piece of stricken land.

2. The valleys of the beheaded streams Khari, Banka and Behula in Burdwan District (West Bengal).

S. C. Bose, Calcutta.

The Damodar used to flow in the past straight towards the east, joining the river Hooghly above Calcutta. It has changed its course several times with disastrous results. Rennell's map shows it flowing along the bed of the Ghoi Nadi of today. Earlier the Damodar occupied the beds of the Khari, the Banka and the Behula successively. They are thus beheaded streams, and their present catchment is severely restricted. Their diminishing volume is reflected in their tortuous meandering courses.

The Khari, the northernmost of these streams, has the biggest catchment. It cuts through old alluvial beds deposited by the Damodar in the past, and at present being dissected and moulded by stream action. The Banka is artificially separated from the Damodar by the embankment in between. The Behula is so much emaciated that it is difficult to recognise it as a river. Even so, in 1943, it temporarily regained its old form, when the Damodar burst its embankment at Manikhati and rushed madly into it.

The beheading has caused a general dryness of the land, accentuated by the sandy character of the soil, the raised alluvial blocks and benches being the worst sufferers. Much land has been encroached upon by dry scrub jungle. The Damodar canal was built to relieve these conditions. But unfortunately it has been a partial success, the planning and execution of it having been done without a proper geographical analysis. The same tragedy should not be repeated and geographers should play their part in the Damodar Valley Corporation to be constituted in the near future.

3. Reviving the great Indian desert.

Maneck B. Pithawalla, Karachi.

A news item was recently flashed from Delhi that the Sind-Rajputana desert was spreading northward and eastward and that too at the rate of half a mile per year. The author has tried to answer this in a brief paper dealing with the physiography of the Great Indian Desert and suggested some ways of reviving the region with the aid of the Engineering Science. Travellers through the desert area, like the late Sir Aurel Stein, have come to the conclusion that the Indian desert is *not a real desert*, but there have been some natural catastrophies such as hydrographical changes and some human interference with nature in the upper reaches of the Ambala streams, such as the destruction of forests, over-grazing, over-irrigation etc. The triple river system of the Ghaggar, Hakra, Wahinda and the Eastern Nara, must have watered, even till late historic times, some 7000 square miles of the now barren land in the north and the west of the Thar.

In recent years and after the construction of the Sukkur barrage, the Eastern Nara has been greatly revived and nearly the whole channel has been converted into a first-rate perennial canal with some 10,000 miles of water courses taken from it. Such a transformation can also be produced in the old Ghaggar-Sarasvati channel in the north of the desert, as there is enough water in the Sutlej to rejuvenate it. Inspite of the

new irrigation projects coming into force both in Sind and the Punjab, some 100,000 cusecs of water will still continue to run to waste into the sea. Towards the eastern part of the desert, much can also be done to control the Luni river system with its half a dozen powerful tributaries. There are a large number of natural reservoirs called *jhils*, which can be prevented from turning into saline lakes with skilful damming and river-training work. Thus there is a trmendous scope for undoing what man as well as nature have done to increase barrenness.

The Paper is accompanied by maps of the desert specially drawn to illustrate its physiography and physiographic divisions and deals with various engineering schemes for conserving the water in this region and for belying the above news item.

4. A geographical survey of Keamari and its gradual growth as a satellite of Karachi City.

MANECK B. PITHAWALLA *and* THOMAS HOWELL, Karachi.

In this paper the geographic aspects of Keamari have been examined step by step. The various factors which are likely to foster or retard the development have been laid bare. Emphasis has been placed on the fact that Keamari reflects the prosperity of Karachi as the parent city, with which it is connected by road and rail.

A detailed account of the living conditions in the area is given, pointing out certain defects which could be remedied, if better planning is instituted.

Any industrialisation of the area has been deprecated, as the satellite's main function is to foster the harbour and its trade and as it would add to the existing congestion and insanitation.

5. The new climatic Divisions of Sind.

MR. G. S. RAISINGHANI, Nawabshah, Sind.

The writer has carried out field surveys, examined the geographical conditions and the economic resources of the province of Sind with a view to prepare a detailed plan for its economic development. The climate has got profound influence on the soil conditions, natural flora, irrigation method and practices, plant growth, crop maturity and yield, industries and human settlements. As a first step towards economic planning, the author, therefore, prepared a map showing climatic divisions of Sind.

Pithawalla (1937) divided Sind into three transverse and more or less parallel climatic divisions viz : I. Upper Sind ('Siro') ; II. Middle Sind ('Vacholo') and III. Lower Sind ('Lar'). But the rainfall figures, wind velocites and maximum and minium temperatures reveal that there are four definite and distinct climatic divisions into which Sind can and should be divided. This necessitates and involves not only revising and shifting of the old boundaries of Pithawalla's three climatic divisions of Sind but justifies splitting up of Pithawalla's Vacholo climatic division into two divisions longitudinally viz 1. Eastern Vacholo Division and 2. Western Vacholo Division.

The paper describes the climatic conditions based upon wind velocities, maximum and minimum temperatures and rainfall figures of each division.

The paper is accompanied by maps of Sind showing Pithawalla's and the author's climatic divisions.

6. A Geographical Analysis of Natural Vegetation of Sind.

G. S. RAISINGHANI, Nawabshah, Sind.

The paper represents a study in plant geography with special reference to the geographical distribution, classification and migration of natural vegetation, industrial as well as other possible economic uses and medicinal properties of the flora of Sind.

The author, after discussing the principles of Plant Geography based upon the responsss of plants to their environment and tracing the history of the study of the natural vegetation of Sind from 1847 to 1947, describes Sind's unique floristic composition and the distribution of natural vegetation on the basis of geographical conditions prevailing in each physiographic division of Sind. It has been shown that natural vegetation being an index of soil conditions, is an aid to soil classification *in situ.*

In the light of the author's new four climatic divisions of Sind, the climatic conditions of each division have been described and the scope of wind and water as agen-

cies for the dispersal of seeds and colonisation of flora in various parts of Sind has been examined. The influence of wind on the migration of flora from the Thar Desert and colonisation in the valley sections has been studied in detail. A list of such emigrant plants has been given and a path of migration has been mapped out. The correlation between the direction of winds, the drifting of sand and the translocation of the flora has been established. It has further been shown that the Laki Range hinders the passage of wind-borne seeds and thus prevents the colonisation of flora of the eastern parts in the western parts.

The general xerophytic characteristics of natural vegetation of sind have been described and affinities between geographical condition and the flora of Sind, Arabia, Egypt, Nubia, the Punjab, Afghanistan and the rest of India have been pointed out. Whereas the Lloyd Barrage in Sind and the enormous water withdrawals from the river Indus in the Punjab have had deleterious effects on the forest vegetation, the other natural vegetation has become richer since the functioning of the Lloyd Barrage. With the advent of perennial irrigation, '*Kal*' (Cyprus rotandus), '*Pan*' (Typha elephantina), '*Sar*' (Sachharum spontanium) and '*Dhaturo*' (Datura stramonium and D. fastuosa) have sprung up in such large numbers that owing to their rapid and persistent growth in the valley sections, they are a serious menace to irrigation and agriculture.

As Pithawalla's 6 Vegetation Belts of Sind (1937) do not include the characteristic Halophytic, Aquatic, Kalardsoil, Rudderal and the Railwayline Side Vegetation Formations, the author has classified the natural vegetation into Formations according to the Schimper's definition of the terms, viz: 1. Halophytic, 2. Mangrove, 3. Aquatic. 4. Kalar soil, 5. Sand, 6. Gravel, 7. Rock, 8. Ruderal, 9. Forest, 10. Cultivated land and 11. Railwayline Side Vegetation Formations.

The flora of each Formation is enumerated and the entire natural vegetation has been analysed according to the habitat, the habit of growth and the adaptive characters. The mechanical and chemical analyses of typical soil profiles supporting different Vegetation Formations have also been given.

The paper is accompanied by a number of maps, an exhaustive Bibliography and a long list showing industrial or other possible economic uses and medicinal properties of the flora of Sind.

The author's present investigation is a part of his work of National Planning in Sind for which he has received a research grant from the University of Bombay.

7. Hydrology of the Upper Ganges Basin.

D. R. Singh, Meerut *and* M. B. Pithawalla, Karachi.

The paper is one of a series of papers on the regional study of the Upper Ganges Basin, the physiography, climatology, etc., of which were dealt with in the sessions of 1943,1944 and 1947.

It deals with the Ganges, its two voluminons tributaries, the Jumna and the Gogra, together with the Ramganga, the Gumti, the Sarda and other smaller rivers.

The rivers of the Basin play a very important part in its wealth and particularly the Ganges is the most convenient source of power in the Basin which has no coal. There are numerous potential possibilities of these rivers on which single, dual and multi-purpose development schemes are possible.

The hydrological data and particularly records of discharges and fluctuations of level and sub-soil water are not available, and where available, are very poorly maintained. If the rivers are tube developed on multi-purpose basis, there will be a great need of opening up more stream gauge stations and of mobilizing the services of geographers, hydrologists, geologists and foresters.

The paper is illustrated with necessary maps, sketches, graphs,etc.

8. Industrial problems, Development and Planning with regard to the Lower Godavari Region.

V. L. S. P. Rao, Calcutta.

In this paper the author examines the scope for industrial development and planning in the Godavari region. The geographic basis and problems of important industries like paper ,rice milling, ceramics, sugar, tobacco, etc., are discussed.

Out of the total population of 18,80,000, the number of operatives employed in the factories is nearly 7200. (i.e. 0.39 percent of the total population which is just below

the Presidency average of 0·42 percent). Out of the 7,200 factory workers, 4,477 are engaged in agricultural industries. Keeping in view the principles of regionalisation and on the basis of the character of regional resources and the nature of raw materials consumed by the existing industries and assuming that the power problem is going to be solved either by hydro-electricity or thermal power, because the region cannot rely on coal as a cheap source of power, industries like the alkali industry, saw mill, match factory, plywood industry, fish oil and fish meal etc., can be developed in the region.

If the industries of the region are going to be planned according to regional concepts, the existing three fold classification of the Godavari region into Agency ,Uplands and Delta cannot be accepted . The author suggests eight regional units and emphasises the need for an Industrial Planning Committee with definite objectives, six of which have been suggested above.

To conclude, the Godavari region possess varied resources, required capital and adequate labour:what is needed is better co-ordination. The limited mineral deposits like graphite and kaolin should be more carefully utilised. It is doubtful whether inustries could be developed to such an extent as to absorb a vast majority of the agricultural population of the region. Agriculture and industry can be integrated by proper regional planning. Vested interests and narrow outlook of the Godavari capitalists and industrial organisers are playing havoc. The neutral policy of the Madras Government has to be given up. The tendency of every potter to become a crucible manufacturer should be sternly discountenanced ; the Godavari industrialists' policy of waiting 'till the apprentice fitter coolie becomes a technical expert' should be abandoned once and for all and the practice of toying with industrialisation generally should be penalised. The Godavari industrualists should be permitted to start ndustries only after the approval of the Industrial Planning Committee.

The landscape, personality and the geo-economic factors should determine the future character and pattern of industrial planning and development in the Godavari region which, as such, has no personality of its own and hence, should be considered as a part of the Northern Circars Region, not only for the purposes of industrial planning but also for regional planning.

9. Calcutta and the industries in its Suburbs.

P. C. Chakravarti, Calcutta.

Calcutta maintains a high population. Labour is cosmopolitan, abundant and efficient. Consumption of finished goods of various orders is great. Both heavy goods and light industries (cottage) would not only find a ready market but also solve the problem of unemployment to a certain degree. Again supply of commodities to markets according to the demand, would make the city self-sufficient. Some of the raw-materials are to be imported no doubt, but industries of various types would change the social condition and the general outlook. Care must be taken to leave untouched the green belts. Location of these industrial concerns must also be away from residential quarters.

10. The Origin of Forces responsible for Disruption of Continents, Mountain Building and Continental Drift.

H. L. Chhibber, Benares.

The chief factors causing the disruption and drift of continents and mountain building are radioactive disintegration and evolution of heat leading to the melting of rocks and their subsequent intrusion and extrusion and the ultimate foundering of large portions of the crust leading to its invasion by the sea ; loss of heat, resulting in contraction causing mountain building on the one hand and geosynclinal depressions on the other ; tension arising as a complement to compression in the adjacent mountain forming area, and being ultimately responsible for the drifting of the disrupted parts of continents.

11. The Origin and Permanence of Ocean Basins.

H. L. Chhibber, Benares.

The term permanence of ocean basins has been employed in a vague and loose sense. Even submarine volcanic eruptions interfere with their permanence. Even in bit, oceans like the Pacific, volcanic islands spring up in the middle or anywhere. More ovog

the upheaval of the geosynclinals, disruption and drift of continents, interfere wit the permanenence of ocean basins. The wandering of the continents across the ocean floor vitiates the idea of the permanence of ocean basins.

12. Pedological Observations on Soils of Darjeeling District.

N. R. KAR, Calcutta.

The paper embodies some of the results of investigations on the soils of the Darjeeling district carried out by the author during the last summer.

The petrological differentiation of the area, as manifested in the Siwalik sedimentaries, Daling clays and Darjeeling gneisses has no appreciable effect on the general character of the soil. The guiding factors in the genesis of the soil of the area are the topographic features and the climatic conditions—a humid micro-thermal monsoonic climate with an annual precipitation concentration of over the whole region, often being skeletal in the steep hill sides and bare rocks near the perched peaks. The soil distribution seems to be mainly governed by the topographic gradient and natural vegetative cover.

Profile studies in the Terai foothills, and in the Kurseong, Darjeeling, Takdah, Kalimpong hills indicate that the area is under a typically zonal soil—acid gray-brown earth, formed in situ, showing a thin, organically rich, black surface layer (A) overlying a thick, often 3-5 ft., fine sandy loam horizon (B), uniformly coloured gray-brown, red or chocolate resting on the bedrock (C). The average clay-content of the soil is about 30 p.c., followed by fine silt, silt and sand. The clay-content varies from place to place in these extremely uneven hill ranges and appears to bear a positive correlation with the precipitation. The reaction is mainly on the acidic side, the PH value on an average being 5.2 and the soil is comparatively rich in organic matter, nitrogen, phosphoric acid, potash and lime. There is evidence of little acid hydrolysis in the soil with consequent high content of exchangeable calcium, uniform distribution of sesquioxides with no widespread eluviation and no strong decomposition of silicates in the B horizon. This acid hydrolysis increases towards the north till near cool temperate Sikkim podzolised grey-brown earths are to be seen, and it decreases gradually south wards till on the foothills near the plains laterised red-earths make their conspicuous appearance.

13. Some Problems of Snow Survey in Eastern Himalayas.

BIKASH BASU, Calcutta.

Snow Survey helps to determine the relative amount of run-off contributed by snow-melt at various stages during the months of March-April-May by calculating the water equivalent of snow cover which will melt at those successive stages. This forecasting of run-off from snow-melt is an essential factor in the successfull development of the multi-purpose schemes concerning river basins.

The amount of water that may be contributed by the melting of snow cover to the discharge of the streams in the months of March to May will be determined by the total accumulation of snow cover prior to the melt-season below the permanent snow line and the total area of the snow covered zone within the catchment basin. In the Eastern Himalayas the summer Snowline, that is the line above which the ground retains its snow cover in Summer, lies somewhere above 18,000 ft. But I would prefer to call the zone between 18,000 ft. and 22,000 ft., the Glacial Melt Zone and that above 22,000 ft., the Glacial Evaporation Zone. Below 18,000 ft. the winter snow landscape may be divided into two major zones. The upper one lying between 18,000 ft. and 13,000 ft, may be called the zone of Winter Snow Cover. Below 13,000 ft. and upto an altitudinal limit varying between 10,5000 ft. and 7,500 ft. there lies a Zone of Unstable Winter Snow Cover. In the Eastern Himalayas the bulk of the snow fall comes in the S. W. Monsoon season and this snowfall occurs in the Glacial Zone above 18,000 ft. Naturally the melt-water contribution in the streams from this zone is not very great. The winter snow-fall is primarily limited to lower elevations and comes during the passage of depressions. As the characteristic airmass in this seasson is NPc, which contains the lowest amount of initial moisture content of all the seasonal air masses in this part of India, the snow fall is usually very light and spotted in character. Moreover, after the snow fall comes the bright sunny spells and the snow cover usually disappears from the ground. So there is no opportunity to measure the accumulated snow in March or April and help in forecasting the discharge in streams during the critical months of March to May. These and certain other conditions in the Eastern Himalayas, discussed at length in this paper, seem to defeat the purpose of Snow Survey.

SECTION OF PHYSICS

PRESIDENT : DR. L. A. RAMDAS, M.B.E., M.A., Ph.D., F.A.Sc., F.N.A.Sc., F.N.I.

Atomic, Neuclear Physics

1. Generation of Mesons and its dependence on Meson spin.

S. K. CHAKRABARTY, Bombay.

Mesons obtained at sea-level are produced within the atomsphere but doubt exists regarding the primary which produces these mesons and also the process through which they are generated. Several hypotheses have been postulated of which the theory for the production of mesons by proton-nucleon collisions seems to be more reasonable. On this theory a proton by colliding with a nucleon will generate mesons as well as recoil nucleons and will also loose energy by ionization. In the present paper approximate expressions for the cross sections for different processes have been obtained both for a *transverse* as well as a *pseudoscalar* meson. These have later been used for the calculations of i) the energy spectrum of nucleons at different levels of the atmosphere ii) energy spectrum of mesons (both transverse and pseudoscalar separately) at different levels of the atmosphere produced by primary protons of different energies and iii) the integral spectrum of mesons at the different levels for an assumed energy spectrum levels of the atmosphere produced by primary protons of different energies and iii) the integral spectrum of mesons at the different levels for an assumed energy spectrum of primary protons incident at the top of the atmosphere. The energy spectrum of nucleons obtained here differs considerably from similar results obtained by Peng and the reasons for such differences have been explained. The energy spectrum of the mesons, whether transverse or pseudoscalar, produced by a primary proton are nearly similar except fpr the fact that the number of mesons on different energy regions is larger by a factor 2-3, if the mesons are transverse than if they are pseudoscalar. But this fact cannot be used to ascertain the spin of sea level mesons unless the intensity as well as the energy spectrum of the primary protons are accurately known. The energy spectrum however, depends critically on the proper life time of the meson at rest and comparison of the results of the present paper with the observed results of Wilson show that $\tau=2\cdot7\times10^{-6}$ sec. The observed knee of the latitude effect can however, be explained whether the mesoms are transverse or pseudoscalar.

2. Nuclear Isomerism of Bromine 80 and the exited states of the Nucleus.

S. D. CHATTERJEE, Calcutta *and* N. K. SAHA, Delhi.

Earlier it was shown by one of the authors (N.K.S.) that the upper limit of the β-ray spectrum of the 18 min. and 4·4 hr. isomers of Br. 80 as obtained by slow neutron bombardment of bromine is the same within the limits of experimental error. In the present work (a) the same result is confirmed by a slightly improved method of measurment ; (b) the upper limit is also determined for the two periods excited by fast neutron bombardment. For the 18 min. period the upper limit is found to be $\sim$2·26 Mev and that for the 4·4 hr. period $\sim$2·02 Mev, practically the same as that under slow neutron bombardment ; (c) the excitation ratio of the two activities of 18 min. : 4·4 hr. period is studied as a function of the excitation energy of the bromine nucleus as obtained by

the bombardment of Br. by (i) slow neutrons, (ii) fast neutrons and (iii) a mixture of fast and slow neutrons. The excitation ratio in the three cases is found to be ~2·1, 2·69 and 2·3 respectively with a probable error not exceeding $\pm 0 \cdot 2$. Well known chemical methods of concentration of active Br. 80 in conjunction with G. M.—counters and mechanical recorders were used in these experiments.

In order to explain the observed variation of the upper limit of the β-ray spectrum and the excitation ratio of the isomers with the energy of excitation of the Br-nucleus, an energy level scheme of Br. 80 and Kr. 80 nuclei has been suggested. According to this a metastable state of ~48 KeV and an excited state of ~0·2 Mev above the ground state are attributed to the Br.80—nucleus, while an excited state ~0·5 MeV above the ground level of Kr80 appears to fit well with a γ—radiation of this energy observed by Snell associated with the 18 min. isomers of Br80 produced in the reaction Br79 (d,p) Br80.

For low excitation by slow neutrons only the 48 KeV metastable state of Br80 s excited, from which it returns to the ground state of Br80 by a (β-less) γ-emission and from there to the ground level of Kr80-nucleus. On the other hand for a large excitation by fast neutrons the 0·2 MeV excited state of Br80 is also excited in competition with the metastable state. This highly excited Br80-noucleous returns to its ground state by an "allowed" γ-emission and then passes on to the ground (or excited) level or Kr80 giving an 18 min. β-ray spectrum of the highest upper limit of ~2·2 MeV and the increased excitation ratio of 2·69 of the two activities of 18 min. : 4·4 hr. periods.

3. Neutron-Deuteron scattering.

C. K. SUNDARACHAR, Bangalore.

Neutron-deuteron scattering cross-section values deduced on the basis of current theories do not fit with experimental values, particularly at the lower energies. It may be that the interaction potential assumed in the theory is not correct or that there is an interference effect between potential and resonance scattering. An anomaly in neutron-deuteron scattering at 0.7 Mev. neutron energy has been noticed by the author. (*Nature*. 149. 51. 1942.). Similar anomalies have been noted by other workers in the scattering of low energy neutrons by the lighter elements. Results of a new experimental study of neutron-deuteron scattering, using a heavy paraffin as the scatterer, reveal resonances at the lower energies.

4. Characters of Cubic Groups.

T. VENKATARAYUDU *and* V. RAMAKRISHNAMURTY. Waltair.

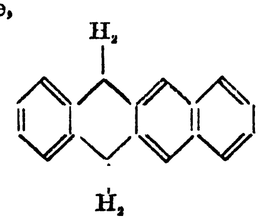
The point groups isomorphous to the cubic space groups are extended by taking the primitive translations T_x, T_y, T_z as distinct from indentity but satisfying the relation $T_x^2 = T_y^2 = T_z^2 = E$. The characters in respect of such extended groups have been worked out.

Crystal Physics, X Rays and Crystal Structure, etc.

5, Crystallographic studies on 9 : 10 Dihydro-Naphthacene.

S. L. CHORGHADE, Nagpur.

9 : 10-Dihydro-naphthacene,



crystallizes in the orthorhombic system. Good single crystals can be grown by slow evaporation of a solution of the substance in ethyl acetate. They appear as six-sided tabular plates parallel to (010) bounded by (101) and (120) faces, and elo-

ngated along the 'c' axis. Occasionally, (110) and (001) faces are also developed. Since no pyramidal faces appear on the crystals so far examined goniometrically, morphological data do not enable us to decide whether they belong to the pyramidal or bipyramidal class of orthorhombic system.

From several sets of rotation and oscillation photographs taken about the three crystallographic axes with $Cu.K_{\alpha}$ radiation ,it is found that the unit cell of the crystal has the dimensions

$$a=7\cdot58, \quad b=25\cdot77, \quad c=6\cdot08 \text{ A},$$

and that it contains 4 molecules of $C_{18} H_{14}$.

Optically, the crystals exhibit strong negative birefringence. Preliminary measurements of the principal refractive indices of the crystal for the D lines of sodium gave

$$\alpha=1\cdot60, \quad \beta=1\cdot74, \quad \gamma=1\cdot92,$$

$$a=\alpha, \quad b=\gamma, \quad c=\beta, \quad \text{and } V\approx46°.$$

The direction of vibration of the slowest ray and the long spacing of the crystal along the b' axis show that in the crystal of 9 : 10-dihydronaphthacene the molecular lengths lie along the 'b' axis. The direction of vibration of the fastest ray in the crystal and the 'a' and 'c' dimensions of the unit cell point to the conclusion that the normals to the planes of benzene rings in the molecule of 9 : 10-dihydronaphthacene make small angles with the 'a' axis of the crystal.

6. Isothermals for Rock-salt at high temperatures.

Dr. B. Dayal. Benares.

The isothermals at various temperatures for rock-salt have been drawn theoretically. The static part of the pressure has been evaluated from the standard form of the potential function, while the calculations of the thermal part are based on Raman's theory of crystal vibrations. Compressibility and thermal expansion have been calculated from these curves and agree with the experimental values upto 900°K, the theoretical values increasing abnormally above this temperature. The pressure coefficient of compressibility has been calculated theoretically and is found to be in very good agreement with Bridgman's measurements.

7. Elastic frequencies of Amethyst and Smoky Quartz.

Bh. Krishnamurty, Waltair.

By the Ultrasonic method, using Debye and Sears phenomenon of the diffraction of light by Ultrasonic waves, the elastic frequencies of Amethyst and Smoky Quartz are determined with specimens of different depths of colour, and after complete decolourisation by heating at high temperatures. In both cases, the elastic frequencies differ from those of colourless quartz. They, however, show no correlative variation with depth of colour, and are not altered after decolourisation. Specimens from very thickly coloured portions of a crystal of Amethyst do not oscillate piezoelectrically.

Electricity and Magnetism

8. Magnetic susceptibilities of Alkaline Halides.

P. D. Pathak *and* D. V. Gogate, Baroda.

A precision method which is a modified form of Gouy's method was developed in this laboratory for the measurement of magnetic susceptibilities and it was used for determining the susceptibilities of Sodium, Potassium and Lithium halides. The object of this investigation was to examine (a) the validity of the law of additivity in the case of the above salts, and (b) the discrepancies between the observed and calculated values of their susceptibilities. This is probably the first attempt to determine the magnetic susceptibility of Li I in *anhydrous* form. It is found that the law of additivity holds to a first approximation in case of sodium and potassium halides but breaks down completely in the case of Li salts. It is suggested that the observed progressive increase in the differences between the calculated and observed values as we pass from Li-CL to Li-I may be due to the interaction between the outer shells of the small positive ion and the heavier and powerfully charged negative ions.

9. The magnetic properties of Ferrous Sulphate Heptahydrate from room temperature to 80°K.

BHAGAWATI CHARAN GUHA, Calcutta

The temperature variation of the principal magnetic susceptibilities of $FeSO_4$ $7H_2O$, shows that there is an essential similarity between this crystal and the ionic cobalt salts regarding their magnetic properties. The anisotropies in the two cases are nearly of the same magnitude and incorase about seven times from room temperature to 80°K. The square of the mean magnetic moments is lower than the theoretical value for the free ion, by the same amount as in cobalt salts, and it decreases with fall of temperatue in the same manner. The reason for all these findings should be attributed to the fact that the lowermost level of the Stark pattern in a cubic field in both Fe^{++} and Co^{++} ions is a triplet.

There is an axis of magnetic symmetry in $FeSO_4$ $7H_20$, though the crystal structur does not lead to it.

10. Dielectric constants of Marbles and Limestones.

D. A. A. S. NARAYANA RAO, Waltair.

The dielectric constants of white marble of Jubbalpore, grey marble of Hyderabad, pink marble of Rajaputana, Kurnool limestone, Bhima limestone and Planad limestone are determined in the dry condition at a froquencey of 1.6 mega cycles by a liquid mixture method. Sections in different directions of the same specimen are taken. The values are ranging between 7.7 and 8.6. Differences between the different coloured marbles are not as high as reported by previous observers. The dielectric anisotropy was found to be very slight, and no definite conclusions could be drawn from it.

11. A note on the equivalence of the Riesz method and the λ-Limiting process.

F. C. AULUCK, Delhi.

In the framework of the classical electromagnetic theory divergence.free results can be obtained either by the λ-limiting process due to Wentzel, Dirac, and Pauli or by using the powerful method due to Riesz where the potential is obtained by analytica continuation to $\alpha=0$ of an arbitrary parameter α. Recently Ma has established th' equivalence, in the case of the field of a point source, of the λ-limiting process and th- Riesz method, In this paper the above equivalence is established by an alternative method, In the case of the electromagnetic field we define the potential A^{ret} at the (space-time) point x_μ as

$$A^{ret}\left(x_\mu\right)=\frac{1}{2i\pi}\int_C \frac{S}{K}\frac{dR}{R},$$

where R is the hyperbolic distance between x_μ and a point z_μ (τ) on the world line of the point source (τ denote proper time) ;

$$R^2=\left[x_\mu-z_\mu(\tau)\right]\left[x^\mu-z^\mu(\tau)\right]$$

$$K(\tau)=\left[x_\mu-z_\mu(\tau)\right]\frac{dz^\mu}{dT},$$

C represents a suitable contour in the R-plane enclosing only the point $R=0$ correspon· ding to the retarded value of $\tau(\tau=\tau_1)$.

Electronics and Ionics

12. Ratings of low Power Rectifiers.

S. V. CHANDRASHEKHAR AIYA and C. S. SHIVARAM, Poona.

For the supply of d.c. from a.c., a power supply unit employing a rectifier is generally used. The physicist generally employs low power rectifiers but his requirements of constancy of supply voltage are much greater. Generally the performance characteristics are given by the manufacturers by a set of curves, voltage against current. Recent work has led to the conclusion that certain additional parameters have to be supplied. It is shown in this paper that a more important quantity, the R_i of the tube for different filament voltages is also necessary.

13. Influence of Temperature on *Joshi-Effect* in Oxygen.

S. R. MOHANTY, Benares.

Joshi-effect Δi in oxygen enclosed in a sealed Siemens' tube at 331 mm (32°C) has been studied at different temperatutes t in the range 30-125°C. The gas was excited at various V increased over 2-5 KV of 50 cycles frequency. The A.C. indicator was a vacuo-junction.

At constant V, the discharge current i increases markedly with t. Thus, at $t=33°$ and 125°C, iD in dark due to 2.67 KV was respectively 4.00 and 10.35. The 'threshold potential' Vm and also the net effect Δi increase with t up to 50°C and then decreast. Thus *e.g.* Vm was 2.31 KV at 33°C, rose to 2.37 KV at 50°C, and decrease with further rise in t to 2.19KV at 125°C. The variation with t of electrical breakdown of solid dielectrics in similar (Hippel, *Trans. Faraday Soc.*, 1946, 42A, 78). At the above V, Δi increased from 1.17 at 33°C to a maximum of 1.26 at 50°C, and decreased at higher t to 0.50 at 125°C. The relative effect % Δi, however, decreases regularly with t. It was, at the above V 29 at 33°3 and 5 at 125°C.

Joshi (*Phys.Sec.*, Abst.26, 1946 ; *Cur.Sci.*, 1946,15,281 ; 1947,16,19) has suggested the formation of an electrode layer as primary to Δi. Since temperature would decondition the electrode layer, a decrease of Δi may be expected.

14. Influence of Light-Intensity on the *Joshi-Effect* in Chlorine under Silent Discharge at Various Gas Pressures and Exciting Potentials.

B. KAMESWAR SARMA, Benares,

Using 6H6 (R.C.A.) double diode as A.C. indicator, the dependence on the above factors of the *Joshi-effect* Δi is investigated in the range, the potential V, 1 to 10 KV ; the gas pressure p, 5 to 300 mm Hg ; and the relative light intensity I, 1 to 480.

The effect Δi increases with I more rapidly at small than at large I ; at the latter a saturation is perceptible. The Joshi-Lakshminarayaniah equation, $\Delta i = aI^b$, where a and b are constants, was found applicable at low light intensities I. Further-more the curves, log Δi-log I, tended to be linear at low exciting potentials V, in agreement with the above equation. At large V, the curves showed a concavity towards the intensity axis which has been generalized by Joshi as characteristic of this phenomenon.

The relative effect % Δi increases with p upto a maximum, decreases and then tends to increase again. Thus at 5, 20, 60, 100, 200, 300 mm Hg pressure, the maximum % Δi is 48 ,50, 52, 38, 30, 37 respectively. The threshold potential Vm increases with p, from 1.2 KV at 5 mm to 7.7 KV at 300 mm. The net effect Δi increases with V ; the relative effect % Δi, however, decreases.

15. Influence on *Joshi-Effect* in Chlorine of the Inter-electrode Spacing in an Ozoniser Discharge at 50 and 500 Cycles Frequency

N. ATCHUTA RAMAIAH, Benares.

Joshi (*Indian Sci. Cong., Phys. Sec.*, 26, 1946 ; *Curr. Sci.*, 1946, 15, 281) has ascribed the effect Δi *inter alia* to emission of photo-electrons from a boundary layer formed under the discharge. These electrons are captured by excited gas molecules

and atoms to form negative ions. Since the probability of electron capture depends upon p/E, where p is the gas pressure and E the field, *ceteris paribus*, Δi should decrease with E. Earller, E at constant p was varied by altering the alied V. The dependence on E of the effect Δi is now studied by varying l the inter-electrode distance at cinstant p and V.

Three ozonisers A, B and C, of the same outer diameter and with d_i of 2, 4 and 6 mm respectively, were filled with purified chlorine at 500 mm pressure and excited at V varied in the range 2-14 KV of 50 cycles, and o ·5-6.0 KV of 500 cycles frequency. The 'threshold potential' Vm varied linearly with d. At constant V, both Δi and % Δi increased with d. Thus e.g. at 9·6 KV of 50 cycles Δi was 0·4 (A), 1·6 (B) and 2·3 (C);the corresponding % Δi was 21, 49 and 62 respectively. Results were similar at constant iD. Thus, with 500 cycles, at $i\text{D}=6.4$, % Δi for the above inter-electrode spacings was respectively 29, 34 and 39.

Increase of d at constant V reduces E, leading, on Joshi's theory (*loc. cit.*), to an increase of Δi, as observed.

In accord with Joshi's postulate of the formation of a boundary layer as fundamental to the effect Δi (*loc. cit.*), it was found that its magnitude in the freshly prepared ozonisers increased progressively with '*aging*' under the discharge.

16. Comparative Studies of *Joshi-Effect* in Chlorine under Semi-ozoniser excitation at 50 and 500 cycles frequency

D. V. RAMANA RAO, Benares.

Previous work on this phenomenon, Δi, refers chiefly to Siemens' tubes as the excited system (Joshi. Pros. Add., Chem. Sec., *Indian Sci. Cong.*, 1943 ; Joshi and Deo *Nature*, 1944, 153, 434) This has now been extended to a semi-ozoniser discharge,. The influence of the following parameters has been studied at both the frequencies mentioned above : the applied potential was varied from 1·0 to 5·0 KV at 50 cycles and from 0·2 to 1·0 KV at 500 cycles frequency ; the gas pressure from 5 to 400 mm and the relative intensity of light from 1 to 530. The detector was a diode 6H6 (RCA inductively coupled with the L.T. of the discharge tube.

In this pressure range, for both the frequencies, the threshold potential, Vm, is sensibly a linear function of p. At a given p, the net effect Δi increases with V to a constant maximum. The relative effect % Δi (100 Δi/iD), however is a maximum near Vm and decreases thereafter. Thus *e. g.*, at 100mm pressure, Δi increases from 1·1 at 1·6 KV to 6·5 at 4·05 KV ; the corresponding% Δi is 52 and 40 respectively. At a constant V, *viz.*, 2·94 KV, Δi increases from 2·7 at 5 mm to 6·0 at 40 mm pressure. Further increase of pressure to 300 mm reduces Δi to 1·1 The corresponding % Δi is 40, 53 and 26 respectively at the above pressures.

In agreement with the general findings of Joshi (*loc. cit.*) Δi and %Δi increases with increasing light intensity, indicative of saturation.

Fundamentally similar results were obtained at 500 cycles frequency also. The, corresponding Vm was lower and usually, though not invariably, net Δi was greater at the larger frequency.

17. Influence of Capacitative Impedance and the Frequency Filters on the *Joshi-Effect* in Chlorine under Electrical Discharge

NARENDA NATH, Benares.

The marked influence of the above factor (in an unionised state)on the magnitude of the *Joshi–effect* Δi, a photo-variation of the discharge current i, in chlorine was observed by Joshi and co-workers (*Proc. Ind. Sci. Cong. Abst.*28). In the present investigation the effect Δi is studied using neon and helium tubes of Geissler type. The capacities were connected in series with chlorine tube which excited at potentials 2·67 KV to 9·3 KV, at 50cycles frequency, using a double diode as a rectifier. In the first group of results, when whole of the L. T. current was alllowed to pass through the neon tube the glow appeared in it before the threshold potential Vm. of the chlorine tube , the current was large but Δi was not detected before Vm. Remarkably enough, the H. F. part of i showed practically a 100 % of current decrease near Vm; iL. F. showed 39% of current increase under light at low apdlied KV ; and at higher KV this positive effect changed to negative . Next, helium tube was substituted for neon tube. i, the discharge current was greater and % Δi less for helium tubo than in case of neon. Furthermore, Δi was negative near Vm, whereas 6 % of + Δi was observed at higher

KV. At the above mentioned KV, iD, $-\Delta i$ and the corresponding $\%\ \Delta i$ were quite large in H.F. iL.F. did not produce any glow in the helium tube, and therefore did not show any current. These results and the previous ones show that the effect Δi is essentially the same irrespective of the nature of the external capacity and that the chief seat of Δi is the H.F. part of i.

18. Studies of the *Joshi-Effect* in Iodine with a Triode and a Pentode under Various Modes of Operation.

S. N. TEWARI, Benares.

It was observed by Joshi that the value of a capacitance in the path of the discharge current determines appreciably the magnitude of the corresponding light-effect. The role of an external capacitance has been investigated with a triode 37 coupled inductively. It was observed here that $\%\ \Delta i$ increased progressively with the decrease in the serial capacitance but it decreased markedly with the decrease in the parallel capacitance.

Results showed that $\%\ \Delta i$ was always higher under the anode bend than the grid leak detection and that pentode 6J7 showed greater $\%\ \Delta i$ than the triode. When the pentode and triode were coupled resistively the magnitudes of Δi and $\%\ \Delta i$ were greatly reduced and that an inversion of a negative *Joshi-effect* to an apparently positive-effect occurred beyond a certain critical value of the resistance. In the case of the triode the grid current, however, invariably decreased on irradiation but in the case of the pentode, the grid current, and any changes therein on irradiation could not be observed. The most important aspect of the positive-effect was that it often started with a negative kick, was slowly built up and instantaneously destroyed on shutting out the irradiation. In the case of triode the positive-effect may be accounted for (i) sturation due to R.F. part of the signal, (ii) grid-shift towards positive on irradiation.

A shift of the grid bias to higher negative value increases $\%\ \Delta i$ and the positive-effect is shifted to higher exciting potentials.

19. Production of *Joshi-Effect* in Oxygen in Semi-ozonisers.

S. R, MOHANTY *and* P. C. PRADHAN, Benares

Joshi-effect has been studied in oxygen filled at different pressures in the range 50-500 mm in semi-ozonisers, the central high tension wire being gold ,silver ,and copper under comparative conditions. The exciting potential V was varied over 0·5-5·0 KV of 50 cycles frequency. The detector was a diode 6H6 used as a hallf wave rectifier; it was coupled inductively with the L.T. of the oxygen tubes. No effect was observed below V*m*, the potential necessary to initiate a discharge. Above V*m*, *i* increased with V; the relative effect $\%\ \Delta i$, *i.e.*, $100\ \Delta i/iD$, however, was maximum at V*m* and decreased with V. Thus *e.g.* at 50mm with a semi-ozoniser containing a H.T. wire of gold, Δi increased from 0·4 at 0·67KV to 1·5 at 4·67 KV; the corresponding $\%\Delta i$ was respectively 33 and 12.

At constant *i*D, the effect varied in the order gold > silver > copper. Thus *e.g.* at the above pressure and $iD=6$, $\%\Delta i$ was 14 (gold), 5(silver), and 2 (copper). This difference has been traced to the catalytic activity of the metals concerned. The effect has also been studied at 500 cycles frequency.

Light

20. Passage of Visible Light Through Cloud and Fogs

Y. G. NAIK, Ahmedabad.

When a beam of light passes through a fog, the portion of beam intercepted by the particles in the cloud is scattered by them in all directions. The amount of light scattered in different directions depends on the size and the refractive index of the drops. This problem was first investigated theoretically by Rayleigh and Love for particles, smaller than or equal to the wave length of light and having small refractive index. Mie developed a general theory applicable to any size and any refractive index.

The present paper deals with three important aspects of the passage of light through artificial fogs, which approximate to the natural conditions in the atmosphere.

(i) It has been shown that the Mie's theory explains not only the formation corna rings but also the scheme of coloration of the Central Corona disc , which the previous theories due to Verdet., Airy and others failed to explain.

(ii) The problem of light transmission, which gave very conflicting experimental evidence from different investigators, has been explained satisfactorily with special reference to the part played by the size and the number of drops scattering the light The minimum wave length of light , corresponding to a given size of particles in a fog or cloud which gives a transmission of light without undue fluctuation of light intensity, has been determined.

(iii) The phenomenon of the Brocken bow or the glory has been satisfactorily explained on the basis of the calculations of the Mie's theory of light.

21. Studies in Colloid optics

P. K. KATTI, Poona.

The phenomenon of the sol-gel and gel-sol transformation for various concentrations of agar-agar has been studied by the colloid-optical technique of R. S. Krishnan. The depolarisation values Pu, Pv,&PH. have been measured in the temperature range of 80°-20°C by using a pair of double image prisms in the usual manner.

The intensity variations have been measured for the above temperature ranges. Values of Pu calculated and observed agree throughout the range verifying the Krishnan relation $V_H = H_V$ and $P_u = \dfrac{1+\frac{1}{P_H}}{1+\frac{1}{P_V}}$ for all concentrations.

At all concentrations the critical temperature below which the intensity of the scattered beam increases is 35°C. The decrease of PH and Pv starts at 33°C. For the gel to sol transformation in warming the gel from 20° to 80°C there are no *sudden* changes at 33° or 35°C, but the polarisations and intensities change over *gradually* to the original 'sol' values of 80°C.

Meteorology, Geophysics, Oceanography etc.

(a) Atmospheric Physics

22. Height distribution of Atmospheric ozone at Delhi.

R. V. KARANDIKAR *and* K. R. RAMANATHAN, New Delhi.

Observations of the zenith scattered light made with Dobson's photo-electric spectrophotometer on clear days at Delhi (Lat. 28° 35'N) during the period November 1945 to March 1947 have been used to determine the vertical distribution of ozone at this place.

Dobson's method A was used to get an approximate idea of the height distribution and this was used as a starting point for the more elaborate method B. Only primary scattering was taken into account, but scattering from layers right up to 100 Km. was considered.

The height distribution of ozone has been calculated, for days with total ozone amounts varying from 0·155 cm. to 0·217cm. and curves of distribution drawn. A decrease in the total ozone amount is found to cause a rise in the centre of gravity. The centre of gravity was found to be 26·5 Km. for 0·155 cm. as compared to 25·0 Km. for 0·217 cm. For the same ozone amount, the height of the centre of gravity lowers as we go to higher latitudes, e.g. for the ozone amount 0·217 cm the height is 25 Km. at Delhi 22·5 at Arosa and 21 Km .at Troms.

Following a hailstorm in the first week of May 1947 at Simla, a marked lowerin of the centre of gravity of the ozone layer was observed.

In calculating the distribution, it was found that while the observed values of the intensity of zenith scattered light could be fitted with the calculated values sufficiently well in the range Z=90°−60°, there were increasing differences as Z approached zero. An attempt has been made to analyse this and it appears that the discrepancy is due to scattering by large particles which are always present even in apparently clear seksi

over Delhi. The effect of scattering by large particles is large at small angular distances from the sun and becomes much less at greater distances. Better agreement can therefore be expected for larger values of Z.

23. Effect of dust and haze on the spectral dtstribotion of zenith-scattered radiation.

R. V. KARANDIKAR, New Delhi.

Observations of the light scattered from the zenith sky made with Dobson's photoelectric spectrophotometer at Jackko, Simla, in April and May, 1947, showed that there were certain wellmarked differences in the values of the intensity-ratios I''/I' and and I'/I as measured on clear and hazy days. Here I, I', I'' are the intensities of the three wavelengths λ (3110A°), λ(3300A°) and λ''(4450A°) respectively, being strongly absorbed by the atmospheric ozone, only slightly and λ'' not at all. When $\log I''/I'$ and $\log I'/I$ were plotted against the zenith distance z of the sun, for the same value of z these were found to be markedly higher on hazy days than on clear days. Simple consideration shows that this is expected.

It was further noticed that, after a rapid decrease in the range $z=90°$ to $60°$, $\log I''/I'$ decreased less and less rapidly below 60°, showed a minimum near about 45° and forther began to increase, the rise being rapid beyond 20°. Calculations of primary molecular scattering showed that the expected curve should steadily decrease with z. These deviations from the calculated curve become less marked on days with less haziness, but still persisted even for apparently very clear skies. Log I'/I also showed similar deviations, but these were less marked and occurred only in the region of low values of z.

This peculiarity of the variations of zenith sky light for small zenith distances of the sun could not naturally be observed in middle and high latitudes and does not appear to have been commented on.

A study of the phenomenon shows that the deviations have their origin in large-particle scattering in the atmosphere in the forward direction and shows itself conspicuously by the presence of an 'aureole' round the sun. The more marked deviations in the case of $\log I''/I'$ provide a means to determine the amount of dust and possibly its height-distribution in the atmosphere.

24. An instrument for the measurement of Infra-red radiation from the atmosphere during day as well as night.

R. S. KALE, Poona.

An instrument for the measurement of atmospheric infra-red radiation is constructed. It consists of two pairs of polished aluminium strips. One pair is blackened and afterwards coated with magnesium oxide. The two pairs are mounted alternately on a horizontal " tuffnol " plate, so as to be exposed to the whole hemisphere. Copper-constantan thermo-junctions are fixed to each of the strips in series and a galvanometer placed in the circuit gives the effective radiation to the atmosphere. Magnesium-oxide has got the reflecting power of 90% in the visible region, but behaves as a black body in the infra-red beyond 4μ. This is exactly the starting point of atmospheric radiation. Aluminium has a reflecting power of 75 to 80% in the visible region and above 90% in the infra-red region. So the MgO coated strips exchange radiation with the atmosphere and are thus cooled while the other pair remains at the temperature of the surrounding air (T). The MgO coated strip can be brought to the same temperature as that of the other pair by passing an electric current through them. From a knowledge on the compensating current (I), and the instrumental constant (K)—known after the calibration of the instrument—the incoming atmospheric radiation (S) can be calculated from the formula,

$$S \equiv \sigma T^4 - KI^2$$

where σ is the Stefan-Boltzmann constant.

This instrument can be used with equal facility during dav as well as night.

25. Variation of Electronic Density in the Ionosphere with Latitude.

S. S. BANERJEE *and* R. N. SINGH, Benares.

Study has been made of the variation of electronic density in the F2—region of the ionosphere over Indian latitudes within the region of longitudes 70° and 90° East. For the above purpose, mean monthly electronic densities at noon have been calcu-

lated from the ionospheric data recorded at Peshawar, Delhi, Bombay and Madras by the Research Department, All India Radio. It has been shown that the observations clearly indicate the lowering of noon-ionization of the F2—region near about the magnetic equator throughout the year, due to geomagnetic control of the inosphere as suggested by Sir Edward Appleton (Nature, 157, 691, 1946) and subsequently explained by Professor S.K. Mitra (Nature, 158, 668, 1946). It has been further observed that due to the above lowering of ionic density there appears to be a region of maximum ionization around the latitude of 20° north, and the rate of lowering of electronic desnity towards the equatorial side increases during the equinoxes. This has been explained to be pre- as suggested by Sir Edward Appleton (Nature, 157, 691, 1946) and subsequently explained by Professor S. K. Mitra (Nature, 158, 668, 1946). It has been further observed that due to the above lowering of ionic density there appears to be a region of maximum ionization around the latitude of 20° north, and the rate of lowering of electronic density towards the equatorial side increases during the equinoxes. This has been explained to be presumably due to thermal expansion of the ionized layers over the equator caused by high temperature in that region with parabolic distribution of ionization. Following Chapman's theory of variation of ionic densities with latitude ,an estimate has been made of the lowering of electronic density due to an assumed increase of temperature over the equatorial region of the ionosphere. The effect of temperature on the ionization of F2—region is further indicated by the reversal of ratio of concentration of electrons between the equinoctical months and winter solstice in the neighbourhood of latitude 25° north.

26. Studies of ionospheric disturbances associated with terrestrial-magnetic, radio and solar effects.

M. V. Sivaramakrishnan, Poona.

The paper presents an account of some magnetic disturbances associated with solar flares and radio fade outs during the period 1937-1946. The ionospheric irregularities associated with four great magnetic storms recorded at the Magnetic Observatory, Alibag (Bombay) are discussed. The approximate travel time of the solar stream of corpuscles from the Sun to the Earth is calculated. An intense flare is followed about a day later by a great magnetic storm far more often than could occur by chance. The presence of a " Crochet " in the magnetic records occurring sinultaneously with the appearance of a solar eruption or flare suggests that there is a radiation from the sun travelling with the speed of light, while the magnetic storm which appears between 18 and 30 hours later seems to be caused by a corpuscular radiation with particles travelling at a speed of 1,000 to 2,000 miles per second. From the simultaneous radio fade out ,in which the total cessation of the ionospheric reflection of short radio wave occurs, a great increase in the ultra-violet emission for the sun is deduced.

An attempt is made to collect a list of sudden ionospheric disturbances of the type from observations made in India for the period 1937-1946.

27. Reflection of Atmospherics from the Ionosphere at night.

M. W. Chiplonkar *and* M. S. Hattiangdi, Poona.

This paper gives further results of investigation on the atmospherics at night carried out during the period March 1944 to November 1945 at Poona. Over 600 photographic records have been obtained and analysed here. The interpretation of these records on the multiple reflection theory of simple atmospherics pulses gives a mean ionospheric height of 91.3 Kms. at Poona. (Lat. 19°N and Long. 73°E). Also there are two other distinct levels viz. about 130 Kms. and 45 Kms. from which reflections are found to occur at times. Distances of the origin of atmospherics have been calculated for over 300 atmospherics. They range from a few Kms. (local ones) to over 3000Kms. Reflection coefficients calculated from the decay of amplitude of the reflected pulses lie between 0·72 and 0·51 and compare well with those found by others at other places. The total number of reflections observed on most of the occasions varied from 10 to 25 the maximum being 42. The field strength at the place of observation varied from about 0·1 millivolt to a fraction of a volt. With a view to find a relation between nature of the high frequency precursors which precede the ground pulse and the different characteristics of the ground -and sky-pulses some typical records have been carefully scrutinised and the results obtained are discussed in the light of the discharge mechanism of a lightning stroke.

A number of records also show wave forms ofatmo spherics which cannot be entri reted on the above mentioned reflection theory.

28. A Statistical study of the conditions of beam wireless communication between India and England in relation to solar and geomagnetic phenomena.

M. W. CHIPLONKAR *and* Y. R. NENE, Poona.

This paper describes and discusses briefly the preliminary results of statistical analysis of the conditions of beam wireless communication between Grimsby (England) and Poona (India), during the period (1930-1943). For this purpose the usual method of assigning character figures is adopted. The Time-Patterns and the march of the mean annual character figures show the 11-year period clearly. The monthly character figures give an annual variation which shows a double periodicity. It is pointed out here that a similar double periodicity was observed by one of the authors in the measurements of the total amount of atmospheric ozone during (1936-1938) at Bombay. The 27-day recurrence tendency is clearly brought out both in the Time-Patterns and the Chree recurrence diagrams which were drawn here with 87 days following and preceding the selected days of high character figure. The frequency of high and low character figures for each of these days also shows this in a novel and striking manner. With a view to studying the conditions of commerciability between India and England in greater detail the daily character figures have been divided further into day-and night character figures, the day representing the nornal period of reliable communication on wavelength 34.17 m. and the night that on wavelength 16.22 m. In general, the conditions were more favourable during the night than during the day ; and the absence of 27-day recurrence tendency in the night figures points to the conclusion that the wave radiation from the sun was responsible for most of the observed unfavourable conditions. Further results are discussed in relation to those obtained by others previously for the transatlantic communication. A close parallelism is observed between all the above variations of conditions of communications and the geomagnetic variations over the same period.

29. "Barisal Guns" and the upper atmosphere.

M. W. CHIPLONKAR, Poona.

Attention is drawn to an old publication of (1888) entitled "Memorandum on the Barisal Guns " other similar papers which give a good deal of information on the nature and distribution in time and space of the loud sounds well known in the North East India since long as " Barisal Guns ". From the existence of the alternate zones of audibility and inaudibility, the direction of sound waves etc. it is inferred that the place of origin of these sound waves lies in the so called " Swash of no ground "in the Bay of Bengal. On the basis of the excursions of sound waves through the upper atmosphere and the dependence of the velocity of sound on temperature an approximate distribution of temperature with height in the stratosphere over the tropics is deduced and compared with those obtained similarly by others in the temperate latitudes. A point of great significance is the steep rise of temperature (from about 220° A at 35-40 Km level to about 350° A at 55-60 Km level) in the ozonosphere deduced here. This therefore furnishes a reliable data which gives for the first time a distribution of temperature at such high levels over the tropics.

(b) Radiosonde and other Meteorological Instruments

30. The calibration Equipment for the F type Radiosonde

S. P. VENKITESHWARAN, Poona.

The paper describes the details of construction of the calibration equipment for the F Type Radiometeorograph using carbon dioxide snow for lowering the temperature. It also describes the calibration equipment for use with a Deep Freeze cabinet imported from America. The method of correcting the readings of the thermometer for emergent column is explained. Details are also given for correcting the readings of the manometer for temperature, variation of the level of mercury in the cistern, and the pressure due to trichloro-ethylne in which the meteorograph is immersed.

31. A portable ground equipment for the F type Radiosonde

S. P. VENKITESHWARAN, A. KESAVAMORTHY, B. B. HUDDAR *and* B. K. GUPTA, Poona.

The paper describes the modifications made in the present ground equipment to make it portable and easier to operate. The aerial is capable of being mounted on

a tripod stand used with pilot balloon theodolites. The recording arrangement consisting of a moving paper tape and an electro-magnet operating an ink fed ni b is replaced by a Cenco high frequency impulse counter. By adopting this arrangement, the time marking device on the paper tape is dispensed with and replaced by an ordinary stop watch. The possibility of simplifying the calibration equipment to calibrate and let off meteorographs with which data can be obtained upto 20,000 ft. at a low cost from a number of stations is also described.

32. Some improvements in the F type Radiometeorograph and an investigation of the performance of the instrument.

S. P. VENKITESHWARAN, V. KALYANSUNDARAM *and* A. P. JAYARAJAN, Poona.

In all types of radiometeorographs where the meteorological element is measured by the movement of an arm acting as a switch in the wireless transmitter, there is an unknown error due to the friction of the pens. This error due to friction was present in the F type radiometeorographs also ; but this was eliminated by cutting a groove about ⅛″ wide and ⅛″ deep just in front of the silver spiral. A simple arrangement was rigged up to seal the aneroids used in the meteorographs under any required exhaustion. Ascents were made on a number of days with two instruments with signallus of different wave lengths attached to the same balloon and followed with two independent receivers and recorders. Different types of meteorographs were released and the agreement between the data examined. The paper discusses the degree of agreement between the data obtained with the two instruments.

33. Distant reading instruments for measuring surface winds.

A. KESAVAMORTHY *and* S. P. VENKITESHWARAN,Poona.

With the increase in aviation, the requisitions for meteorological reports from aerodromes have also increased appreciably. The data have to bbe supplied both for the planes in the air and on the ground with the least possible delay. Different types of instruments have been constructed to measure the velocity and direction of surface wind from the room of the observer without going up to the anemometer or wind vane which are usually located in places not easily accessible. The present paper describes an equipment consisting of an electronic wind speed indicator and a wind vane using selsyn motors. In the electronic wind speed indicator, an r.f. voltage with a frequency of 30 Kcs generated in the observer's room is fed through a pair of cables into a coil fixed in the box carrying the spindle of the 4-cup anemometer. Another coil is fixed just below the first coil and the voltage induced in this is fed into an amplifier through a pair of shielded cables. A brass circular vane with ten sectors fixed on the anemometer spindle and rotating in the space between the two coils makes the induced voltage fluctuate at a frequency which is proportional to the rate of rotation of the anemometer cups. The induced voltage is amplified and the varying portion of the voltage further amplified and converted into square wave pulses of constant amplitude and then fed into a frequency discrimination circuit which indicates the frequency of the voltage variation by means of a micro-ammeter calibrated in miles per hour. The paper also describes the advantages of this method over some of the other methods in use.

34. A Further report on the cathode ray tube spectrograph

A. U. MOMIN, Poona.

The Cathode Ray Tube Spectrograph has already been described briefly in earlier communications to the Indian Science Congress (1947), to Nature (26 July 1947) and to the Symposium on "Atmospheric Processes" of the National Institute of Sciences of India (1946). In this paper some further development and refinements which enable the instrument to be used for quantitative measurements of the emission and absorption spectra of the sun and laboratory sources like the sodium and mercury arcs, Pointolites and the spectral absorption of glass filter and dyes, are given.

A new scanning mechanism is described which converts the rotary motion of a wheel into simple harmonic motion which is communicated to the scanning slit. The movement of the slit itself is utilized for generating a sinusoidal e.m.f. which is automatically synchronized and applied to the horizontal plates of the cathode ray tube. This new feature enables the time base to be 'locked' with the oscillations of the slit and the image on the cathode ray tube remains steady and unaffected by any drift in the rate of rotations of the driving motor.

Another new feature of the instrument is the use of a pre-amplifier for the photoelectric cell, which has now made it possible to study much weaker spectra produced by laboratory sources. Some typical photographs of the emission spectra of mercury and sodium arcs ,the absorption spectra due to atmospheric water vapour and oxygen, in the near infra red region of solar radiation, and spectral absorption in filters and dyes are given.

The results so far obtained are very encouraging and there is no doubt that by using the recently developed multiplier photoelectric cell it will be possible to study extremely weak spectra and make intensity measurements almost instantaneously without resorting to the conventional photographic methods.

35. A comparison of the Catch of rainfall in Shielded and unshielded precipitation gauges.

SALARUDDIN and V. C. SARNA, Poona.

Comparison was made of the catches of 5″ ordinary type unshielded raingauges and those fitted with a Brookes type of shield. One set of these instruments were exposed on the ground and the other on a tower about 119 ft. high. Observations of rainfall made during September and October 1947 showed that the average excess of catch in the shielded raingauge over that of the unshielded one was about 2% on the ground and 8% on the tower. The average wind velocity during the period was 3 miles per hour on the ground and 8 miles per hour on the tower. Experiments were also conducted to find the excess of evaporation in the snow-gauges over that in the ordinary rain gauges which are provided with funnels and narrow necked receivers.

(c) Weather Forecasting, Weather Phenomena, etc.

36. Kiebel's Method of Weather Forecasting Directly Inapplicable to India.

S. L. MALURKAR, Poona 5.

Kiebel gave a quantitative method of forecasting in Russia and got the Stalin Prize for it. Last year, the workers at Massachusets Institute of Technology found that this method did not offer any advantages over previously known methods. A preliminary examination of its applicability to the Tropics is desirable.

The pace of progress in Meteorology has, for the last generation, been set largely by the rapidly expanding needs of aviation. Inevitably, rule of thumb results serving the particular needs with a fair degree of accuracy had to be resorted to. The working equations in a logical development of the subject depend, ultimately, on facts observed in certain areas or conditions. When those conditions do not reproduce themselves in other latitudes, the equations and the rule of thumb results break down. An early work by the author and Ramdas showed that the lapse-rates of temperature very near the ground in the tropics were much larger than the values accepted in text-books and recent work elsewhere. The large values could be accounted for by a fresh investigation.

In weather forecasting, the differences are greater. In the temperate zone, depressions have an eastward motion. The tropical depressions have a west-ward motion. The secondary depression in the temperate latitudes travels much faster than its primary. The author pointed out that the secondary low of a western disturbance travles slower than its primary in the peripheries of the tropical zone. This coupled with the paucity of observations over wide areas gave the apparent effect that disturbances travelled SE wards in the Persian Gulf and intensified-a fact that has entered into climatic records. Attempts were mostly made to reduce all tropical weather into particular examples of extra-tropical weather. This led to avoidable confusion. The large number of workers with experience of weather mostly from the temperate latitudes could not do otherwise. A free India must develop Tropical Meteroology for its own needs and must examine carefully each assumption in the subject. 'Ad hoc' assumptions for each disjointed phenomenon retards progress. It must be made clear that the weather in the Tropics and elsewhere must be particular cases of the general circulation of the world ; i.e. be expansions of functions about different points. Generalised principles are most useful.

The author gave one such principle recently. The direction of motion of a depression or a cyclonic storm is determined by the upper wind motion at about 6 Kms

in the sector corresponding to the "source" mass. The depressions are perturbations on the general circulations of the atmosphere. Due to the fluid structure, the exact boundaries of the perturbation are ill defined. Still general conclusions can be drawn from hydro-dynamics. The motion of the perturbation is being guided by a whole layer of fluid. The wind at 6 Km gives an average value of what is happening in this directive layer. If one takes the vertical height of the depression is about 4 Kms, it would affect up to and be reciprocally be affected by the layers up to 8 Kms. The mean motion at 6 Km may then give the forward motion of the depression. In middle latitudes, the height of the troposphere is confined to about 7·10 Kms. A worke in the more northerly latitude would observe a considerable effect of the depression on the tropopause. The worker in a slightly lower latitude whose tropopause may be at about 10 Kms finds the tropopause as a quiescent layer. Even if other things were equal, a worker with a troposphere extending to 15·17 Kms finds little analogy with either.

But other things are not equal. The gradients of pressure and temperature in the tropics are much smaller than in the temperate zone even at the surface. The changes in the above quantities are small at the surface in most cases of disturbed weather, and necessarily smaller at higher levels of the atmosphere. With our instruments, the changes may not be definitely detectable at heights of 8·10 Kms and certainly not at 15·17 Kms.

The convective layer in a depression seems to be of nearly the same order in the tropics and in the temperate zone. The deeper thickness of the tropical troposphere is due to long period convection and radiative equilibrium. The small variations due to depressions can hardly be expected to penetrate to the tropopause.

Kiebel's thery depends essentially on the fundamental assumtption that the tropopause continues to have the same individual elements with the passage of a depression. The tropopause is a *definite* boundary just like the ground and depression was assumed to affect only the intervening layers. In the tropics, nearly half the height of the troposhpere is apparently unaffected by passing depressions. As such Kiebel's theory cannot find application to the Tropics without serious modification.

Before a satisfactory modification can be thoughtout, oneshould know all the facts in the upper atmosphere of the tropics. This poses new problems. Instruments with much smaller corrections and reliability, which can operate at greater heights than in the temperate zone are required. The theoretical worker must find easily recongnisable criteria which off set the smallness of the changes in the measured quantities. The author has tried to follow Equatorial-Maritime Air by the series of thunderstorms along its path on the land, squally seas and by the smalldiurnal variation of temperature, instead of basing the detection on purely the tepmperature and humidity. A number of other criteria have been given for other Tropical air masses.

37. Lower Level Winds Along the Deltas of the North Madras Coast

S. L. MALURKAR, Poona 5.

During the monsoon months, the winds in the overlapping deltaic region of the north Madras coast are stronger below 3000 ft than at corresponding levels at Madras or at Vizagpatam. This is shown to be a consequence of orography and the equation of continuity. The algebraic sum of the winds at Vizagpatam and Madras at those levels are of the same order but slightly larger than the winds at Masulipatam at the lower levels.

38. Effect of Afternoon Heat Lows on Winds at Lower Levels.

S. L. MALURKAR, Poona 5.

As a continuation of previous work on semi-stationary low pressure areas (Tech. Note.no.20.Ind.Met.Dept.), the places where afternoon low pressure areas can be expected are given. The resulting large diurnal variation of wind is shown to be related to these heat lows. The variation of winds at lower levels at Ahmedabad in winter, at Mandalay in the non-monsoon months, the penetration of sea-breeze to the east of Western Ghats, and the westerly strong winds in the United Provinces on summer afternoons are all at least qualitatively explained. Till now there was not even such an explanation for the last two effects. The sea breeze penetrates over Gujarat not more than 15 to 20 miles, while it penetrated across the Western Ghats, a high range of hills of 2000-3000 ft height, to a distance of even 70 miles.

39. Study of convergence in the field of motion of the air, and its importance in forecasting the development and progress of nor' westers in Bengal.

A. K. Roy

The study of nor 'westers, the violent thundersqualls which spring up in northeast India, and more commonly in Bengal, during the pre-monsoon months, March to May, have for a number of years engaged the closest attention of Meteorologists in India, and a good amount of literature on the subject has already been published in the India Meteorological Department publications and other outside journals. While these investigations have given us a fairly good insight into the thermodynamical structure of the atmosphere which favours the growth of these storms, and enable us now to make a reasonably complete diagnostic study of their development and subsequent progress, the problem of forecasting and issuing timely warnings on all occasions about these storms, with the accuracy that is demanded by the public in general, the district authorities and engineers in charge of works still continues to baffle the earnest efforts on the part of even the most experienced forecasters.

The study of the airmass structure of the atmosphere associated with these thundersqualls shows clearly that the genesis of these thunderstorms lies in the incursion northwards, up to a height of some 5000 ft., of Tc air with sea travel (Tc Tm air mass) or occasionally of Tm air proper round the southern and eastern end of the trough of low over the Gangetic valley, this being overrun by dry air of purely continental type, the lapse rate in which is high and sometimes approaches the dry adiabatic value. Earlier investigations on the subject, and the examination of the day to day distribution of temperature and humidity, as given by radio-sonde observations show that a superposition of airmasses as above gives rise to a condition of 'latent instability' in the atmospheric structure which, under certain favourable conditions, leads ultimately to the violent overturning of the column of the atmosphere, resulting in the release of kinetic energy in the form of a squall. However, as we analyse the synoptic charts of a day on which the conditions are generally favourable for the occurrence of nor 'westers, we find that while the instability of this type prevails over a fairly wide area covered by the wedge of the moist and relatively cool air mass in the lower levels, and while from our experience and theoretical considerations we expect that the most favourable zone for development of the thundersqualls would be some fifty to hundred miles away from the line of discontinuity between the moist and dry air masses and on the moist air side of it, the main difficulty in forecasting accurately about these storms from the point of view of their exact location and time of occurrence is that the process of their development, which depends for its initiation on a certain kind of 'trigger action', starts at only some select points in this area, and that the origin and subsequent movement of the storms depends largely on the kinematics of the air movement ,up to a height of 10,000 ft. or more, over that locality. In a paper read by the author in the Symposium of " Atmospheric Processes ", held in Bombay in 1946, under the auspices of the National Institute of Sciences in India, it was suggested that the thunderstorms of the pre-monsoon season are often the result of waves on a quasi-stationery discontinuity where the two main air masses of the season converge towards each other. This idea has been further developed as a result of the study of the synoptic charts of some of the important nor 'wester days of 1947, and it is seen that a "wave theory" of thunderstorms on a line analogous to the well-known " wave theory of cyclones of temperate latitudes ", gives a helpful clue to the birth and subsequent life history of these more elusive local storms which also, in a a way, reveal some of the characteristics of " miniature cyclones ". Unlike the waves on the " polar front ", on which develop the extra-tropical cyclones, the waves associated with these storms are of much shorter length, and are also decidedly more unstable. A prognostic study of the development of these waves, which is the result chiefly of convergence in the field of motion of air, and of the growth, orientation and subsequent of these waves requires a detailed and careful analysis of the kinematics of air movement up to a height of 5000 ft. or more ,and also as good an estimate as possible of the probable changes thereof, taking into consideration the differential pressure tendencies over the area and the surrounding region during the next 6 to 12 hours.

40. Thundershowers at Madras in North-East Monsoon Season.

B. N. Sreenivasaiah and Venkateswara Rao

An analysis of soundings made prior to the occurrence of Northeast monsoon showers (which invariably occur in the early morning or forenoon) brings out a typical vertical structure of the atmosphere, in which a dry air layer (of relative humidity 40-

60%) is sandwiched in between moist layers below and above. The mechanism of these showers is traced to radiational cooling of the upper layers.

41. On Orographic Rain

P. R. PISHAROTY, Poona.

It is well known that the distribution of rainfall is most noticeably affected by mountain ranges. In weather situations like the southwest monsoon, the rainfall on a hilly coast like the Konkan coast of the Indian Peninsula is said to be purely orographic—that is, caused by the steady ascent of moisture laden air over the mountain barrier. The theoretically possible rainfall has been calculated under the following simplifying assumptions :—

(i) that there is no appreciable change in the volune of air as it moves along the different parts of the same stream surface,

(ii) that the scale of turbulence is small compared with the dimensions of the mountain, and

(iii) that there is no penetrative convection.

The stream surfaces around an infinite circular cylinder, placed with its axis horizontal and embedded in a uniform horizontal field of flow, are given in standard text books on Hydrodynamics. By the conformal transformation

$$Z = \left(z - \frac{a^2}{z} \right)$$

the stream lines around a circular obstacle of radius a are transformed into those around a linear obstacle of length $4a$. One of these stream-lines in the Z plane, approximating to the profile of the actual mountain ridge, is selected and the space below this stream-line is considered as solid. The remaining stream-lines above this solid boundary are then taken to represent the field of flow across the mountain ridge, the wind flow being at right angles to the axis of the barrier.

The vertical velocities at every point in the free air, on the windward side of the mountain, associated with such a stream line pattern are calculated using the conformal transformation already referred to. Employing these vertical velocities, the maximum possible rainfall per day is calculated from the Fulks formula :—

$$R = \frac{780\,a\,p}{T} - \frac{2666\,e}{T^2}$$

where R is the rate of precipitaion of rain in millimetres per hour from a layer of saturated air 100 metres thick and having a vertical velocity of 1 metre per second,

a is the west adiabatic lapse rate in deg.C per 100 metres,

b is $\frac{de}{dT}$ in millibars per deg.C,

T is the absolute temperature, and

e is the saturation vapour pressure in millibars at T deg.A.

It is found that on a strong monsoon day in July, with deep moist westerlies of 40 mph, the orographic lifting over the Western Ghats at Khandala can give rise to a maximum rainfall of only about 4 inches per day. This value is about half of what is actually recorded. The theoretical and the observed values have the same *order of magnitude*. The greater amount of the observed rain is probably due to the existence of penetrative convection over the Ghats even on strong monsoon days, whereby, the air flow does not conform to the ideal hydrodynamic stream lines.

42. Single-station forecasting by Radio-sonde Analysis.

D. VENKATESWARA RAO.

Precipitation indices based on evening Radio-Sonde ascents have been computed for Madras for the rainy period of August to December, 1946, in the manner suggested by Schell (Bull. Amer. Met. Soc., 1946, 27, 164). It is found that a high chance for precipitation within 12 hours of the radio-sonde ascent exists only if the index has a value of not less than 3, as compared with a value of 1 in the U.S.A. Further, when the

index lies between 3 and 5, the rain is mostly of the type of light showers, while when the index is more than 5, equal chances exist for light showers and moderate to heavy rain.

43. "Variation in the Normal Pressure Profile in the neighbourhood of South America, its influence on the S. W. Monsoon in India, and the effect of the sunspot on the variation of the Normal Pressure Profile."

K. S. RAMAMURTI, Poona.

In this paper the normal latitudinal distribution of pressure, P, in South America is assumed to be of the form,

$$P=\bar{P}+R\ \{\text{Sin}\ 6\ (\phi-E)-\bar{S}\}$$

and the effect on the June to September rainfall in the Peninsula and N.W.India of the variation in the parameters P, R, andE as the set of P's defining the equation varies from year to year is studied.

It is demonstrated that the more the transport of air to the South Altantic the farther will the axis of the high pressure belt there be shifted from the equator. *That is, the equatorial cell of meridional circulation expands longitudinally with a strengthening of the circulation.*

The C. C. between mean annual sunspot numbers and R, the amplitude of the pressure profile has been found to be negative and significant.

44. "A preliminary examination of pressure at Poona."

P. S. SREENIVASAN *and* S. S. VENKATESWARAN

The paper deals with the analysis of pressure at Poona from 1889 to 1942. The standard error and co-efficient of variability are very high for October and comparatively higher for June, September and November and these are the months in which the monsoon generally sets in or retreats. The mean pressure was found to be maximum in December and minimum in July. Of the twelve correlation coefficients between any two consecutive months of the year, only the correlation coefficient of the months May-June is highly significant.

45. Rainfall at Patiala.

L. D. MAHAJAN, Patiala.

In this paper the statistical analysis of rainfall at Patiala, and its variability have been attempted.

Major rainfall takes place in the monsoon months from July to September. The mean winter rainfall is one-fourth of the mean summer rainfall. The mean annual rainfall of the last about fifty years is 25·85 inches, standard deviation 8·84 inches, coefficient of variability 34·20% and mean deviation 6·97 inches.

The annual rainfall obeys no law relating to time. The winter rainfall does not depend on the next or past summer rainfall and vice-versa. Often, abnormal high rainfall is followed by an abnormal low rainfall. The annual rainfall mostly depends on its summer rainfall and not on its winter rainfall, which is very small. The mean annual rainfall is irregularly decreasing with the lapse of years.

The average number of days associated with rainfall in a year is 44 and they are irregularly decreasing with the lapse of years. When the number of days associated with rainfall in a year is high, the annual rainfall of that year is also very often high. But the relation is not very rigid.

There is no simple periodic variation of the annual rainfall and the total number of rainy days in a year.

46. The mobility of the small ions of the atmosphere at Poona.

K. S. AGARWALA, New Delhi.

The results of 151 determinations of the mobility of the natural small ion, as derived from the simultaneous observations of the conductivity and the ion-content

taken at Poona at 10 hrs. I. S. T. during the years 1935 to 1937, are given and briefly discussed. The mean values of mobility are found to be 1·06 cms^2. $volt^{-1}$ $sec.^{-1}$ for the positive ion and 1·09 cm^2. $volt^{-1}$ $Sec.^{1}$ for the negative ion. Frequency curves are also given; these indicate different mobility groups. The occurrence of higher mobilities during rain and of lower mobilities during haze has also been pointed out.

(d) Oceanography

47. Tropical Oceanography.

S. L. MALURKAR, Poona, 5

It is well-known that the equations of winds in meteorology and of currents in the oceans are almost similar. The equator is a barrier *ordinarily* for transport of air across it. But under certain circumstances, as in monsoon 'pulses' the air can cut across. The areas of high salinity and of density of sea water are very approximately in the same positions as where the atmospheric high pressure areas exist. The modification due to land masses is greater in the case of sea currents. The data available for working a detailed picture of ocean currents near the equator are few. But the climatic or mean picture given in most books resemble very much what one would have written about wind currents if only some mean values were known . It appears that 'pulses' of ocean currents cross the equator to the other side only at intervals when an accidental barrier is placed across the path of the west -ward moving current and the deflection towards the pole is made impossible by a suitable pressure gradient. The exact conditions when these favourable circumstances occur can not be determined unless one has detailed observations of salinity and temperature over a wide area on either side of the equator. The only general conclusion that one has is that the gradient of salinity and temperature is much smaller near the equator than near the temporaate latitudes. This exactly corresponds to the smallness of the pressure gradient near the equator in the atmosphere.

General Physics, Properties of Matter, Acoustics, etc.

48. Further Studies on Thermal Repulsion

M. K. PARANJAPE, Poona.

In previous papers on the subject (Ramdas, Paranjape, Joglekar) observations had been made on the deflections of a light mica vane suspended in a thin vertical air cell whose faces are maintained at a small difference of temperature and it had been shown that the seat of thermal repulsion force is in the temperature gradient in air and that the phenomenon can be studied in its true simplicity when the convection is eliminated by taking a sufficiently thin air cell. The present writer resumed this investigation and studied the phenomenon at various pressures and in various gases. The results obtained are summarised below.-

1. As the air pressure was reduced from the atmospheric pressure to about 10^{-4} cm. of mercury, the thermal force increases at first, reaches a maximum and then decreases again.
2. As the initial position of the vane was varied from the hot to the cold surface it was seen that both the maximum thermal force and the optimum air pressure increase as either surface is approached.
3. Working with air cells of different thicknesses it was found that the product of thickness and the optimum air pressure was approximately constant.
4. A number of experiments were made with mica vanes of different perimeters and areas. There was found to exist a linear relationship between the area of the vane and the thermal force on it, while no regular relation whatever was seen between the thermal force and the perimeter. The possibility of the phenomenon being an edge effect was thus eliminated.
5. The effect of the thermal conductivity of the material of the vane was studied by replacing the mica vane with an aluminium vane. The difference in the behaviour was only a slight one in comparison with the large ratio of the thermal conductivities of aluminium and mica.

6. Experiments made with the mica vane parallel to the temperature gradient showed, contrary to expectation, quite a large deflection, small though in comparison with the deflection in the case when the vane is perpendicular to the temperature gradient.
7. The investigation was carried out using He, H_2, air, CH_4, A, CO_2, C_2H_4, SO_2, CS_2, CCl_4. As one moves down the series it is found that the maximum thermal force F_m and the optimum gas pressure P_m go on decreasing. Linear relation was found between F_m and the mean free path at N.T.P. The plot of log F_m and log P_m is a straight line.
8. It has also been shown that from the deflections of the vane in the 'parallel' and 'perpendicular' position respectively the 'accomodation coefficient' can be estimated.

49. Raw materials for glass industry in the Andhra

VAVILALA KRISHNAMOORTHI, Waltair.

The available raw materials for glass industry in the Andhra area have been studied ; a case has been made out for four glass factories in the Andhra area at Vizagapatam, at Guntur, at Nellore and at Kurnool.

50. A new type of Hygrometer using cellophane.

B. SWAMINATHAN, Udaipur.

Cellophane undergoes very considerable expansion and contraction on damping and drying. This property was investigated, to find out to what extent it could be used for the construction of a hygrometer. The result of these investigations established (1) that a linear relation exists between the length of a cellophane strip and the vapour pressure of water vapour, (2) that the temperature effect on the length was negligible (3) that the values of α and β the ratio of the maximum weight of water vapour absorbed to the weight of dry cellophane and the coefficient of hygrometric expansion respectively are 0·5 and 0·073. These are high when compared to other hygrometric substances. It is therefore concluded that the substance is eminently suitable for use in the construction of hygrometers.

51. On the derivation of adiabatic relations for a real gas.

V. N. KELKAR, Poona.

In the present paper it is pointed out that in deriving the adiabatic relations for a real gas both the laws of thermodynamics (first & second) are not necessary as has been stated in standard text books of heat ! and a simple and straight forward derivation is given on the assumption of the first law only. Taking Van der Waals's equation, a typical equation of state for a real gas, the relation obtained between pressure and volume is :-

$$p\,(v-b)^{\gamma}+\frac{\gamma}{(2-\gamma)}\cdot\frac{a}{v^{2-\gamma}}-\frac{\gamma+2)}{(3-\gamma)}\cdot\frac{ab}{v^{3-\gamma}}+\ldots\ldots=\text{Constant}$$

and that between volume and temperature is :-

$$T(v-b)^{\gamma-1}-\frac{a(v-b)^{\gamma}}{R\,v^{2}}+\frac{\gamma}{2-\gamma}\cdot\frac{a}{v^{2-\gamma}}-\frac{\gamma(\gamma+2)}{(3-\gamma)}\cdot\frac{ab}{v^{3-\gamma}}+\ldots\ldots=\text{Constant.}$$

The relation between pressure and temperature being complicated is obtained as an approximation :-

$$\frac{T^{\gamma}}{p^{\gamma-1}}+\frac{\gamma(\gamma-1)}{(2-\gamma)}\cdot\frac{a\,p^{2-\gamma}}{R^{2}\,T^{2-\gamma}}+\frac{a^{2}\gamma p^{3-\gamma}}{R^{4}\,T^{4-\gamma}}-\frac{\gamma(\gamma+2)}{(3-\gamma)}\cdot\frac{abp^{3-\gamma}}{R^{3}\,T^{3-\gamma}}+\ldots\ldots=\text{Constant.}$$

52. Elastic Impact of Pianoforte Hammer.

R. N. GHOSH.

This paper summarises the dynamical theory of Impact of felt hammer upon a distance a from one fixed end such that reflected wave from the other distant fixed end does not reach the striking point during the time the hammer is in contact with

the string. Heaviside operational method leads to a solution in the form of a series consisting of *incommensurable terms with damping coefficients increasing with the order of the term* and tending to a limiting value. In the case of hard hammer the damping coefficients decrease and the terms are very much less incommensurable. These are the *essential differences* between the two cases that lead to smoothening down of the pressure and time curve between the hammer and the string.

53. Air Flow near Reed Vibrator

R. CHATTERJEE.

The paper gives an account of the experimental work determining air flow and pressure as air flows out through 1) chinks in a steady reed and 2) a vibrating reed. The velocity of flow is determined by hot wire anemometer and the pressure by a sensitive inclined manometer in the case of non-vibrating reed. The isobars indicate a region of low pressure near the reed and also a depression at a height of 1·5 cm. above the reed. In the case of the vibrating reed the pressure is detected by a pressure probe fitted to a microphone and a rectifier. The maximum value of pressure and velocity fall at the same regions indicating that the pressure is negative. Experiments are in progress and it is expected fuller details will be availbale in a short time.

54. On an analysis of Newton's second law of Motion

NARAYAN MISRA, Cuttack.

The second law states that the rate of change of momentum is *proportional* to the impressed force and takes place in the direction in which the force acts. The amend ment suggested is that the word 'proportional' should be substituted by the word 'equal'. The second law is represented by the equation P = K m f. The various methods employed to determine the value of K have been shown to be wrong. The cause of the failure of all attempts to determine the value of K has been shown to be the fact that it is impossible to find K so long as P is found in terms of m f, i.e. in terms of rate of change of momentum it develops. From the equation $K=P/mf$ it may be seen that K cannot be found unless P and mf are measured independently. Force has been shown to be nothing but a rate of change of momentum. This conception of force provides a new method of finding the value of P. A comparison of this independent value of P and the rate of change of momentum developed by P shows that K is unity. The equation P=K mf. then becomes P=mf. So it is necessary to amend the law as suggested.

Spectroscopy

55. Hutchisson's Band Intensity Theory and C_2 (Swan) Bands in Flame Sources : Part I, Oxy-coalgas flames.

N. R. TAWDE *and* J. M. PATEL, Bombay.

Theoretical values of intensities in Swan bands have been calculated for C_2 (Swan) system by using Hutchisson's intensity integral in the manner done previously by Tawde and Patankar in the case of N_2 second positive bands. (Proc. Phys. Soc. 55, 396, 1943). These have been compared with those determined experimentally by photographic photometry for several oxy-coalgas flames (having coalgas and oxygen mixed in the ratios 1·2, 2·0, 3·0, 4·0, and 5·0). It has been noted that experimental results tend to show better agreement with theoretical values (a) for bands with lower vibrational quantum numbers, (b) when quantum numbers are interchanged and (c) for flame having fuel and oxygen in the ratio 4 : 1.

56. Hutchisson's Band Intensity Theory *and* C_2 (Swan) Bands in Flame Sources : Part II, Air-coalgas Flames.

N. R. TAWDE *aad* J. M. PATEL, Bombay.

As a continuation of the Part I of the investigation, flames produced under uniform conditions of coalgas mixed with oxygen in one case and coalgas mixed with air in the other have been investigated. The fuel-oxygen or fuel-air mixtures are taken in the ratios 1·2 and 2·0. The theoretically predicted intensities when examined in relation

to experimental results reveal increasing departure between the two as air replaces oxygen in the fuel mixture. Attempts have been made to explain this and other relevant phenomenon.

57. Hutchisson's Band Intensity Theory and C_2 (Swan) Bands in Flame Sources : Part III, Meker Burner and other Common Flames.

N. R. TAWDE *and* J. M. PATEL, Bombay.

Further theoretical aspects of intensities of Swan bands in Meker burner, Bunsen burner and primus stove have been examined. The Meker burner flame has been investigated under two conditions i.e. (1) burner fully open to air and (2) burner practically open to air. Besides the experimental study of the intensity theory, many other points about the flames, viz. energy equilibrium, chemiluminiscence, etc. have been examined and discussed in the light of the results.

58. Behavior of mercury line spectrum in presence of foreign gases.

N. R. TAWDE *and* K. S. KORGAOKAR, Bombay

While studying the effect of oxygen on nitrogen band spectra, our attention was drawn to the weakening or strengthening of certain emission lines of mercury (present as impurity) as a result of the presence or absence of these gases in the discharge tube. It was noticed that while nitrogen is practically neutral towards the mercury spectrum, oxygen or air quench the spectrum to a marked degree. The intensity of mercury lines undergoes quick reduction and goes below about half the original intensity when the pressure of oxygen is about 1 mm. The fall in intensity is confined to almost all the lines and not merely to the resonance line 2537 A. This problem has been pursued quantitatively by taking the photographs recording the mercury lines at vatious known pressures of these foreign gases.

59. Study of Swan Bands in Under-glycerine Spark.

N. R. TAWDE *and* K. GOPALKRISHNAN, Bombay.

It is well-known that a condensed spark between carbon electrodes under glycerine gives Swan bands. When producing these bands by this method, it was noticed that they undergo relative intensity changes as a result of change in the conditions of electrical circuit causing the spark. In order to study this aspect in terms of energy reactions going on in the spark in presence of glycerine, quantitative study of the enhancement of C_2 and CH bands among themselves or with respect to each other has been undertaken by change of electrical conditions. Control and knowledge of precise electrical conditions offered some difficulties. Attempts have been made to solve them Preliminary qualitative observations have shown some interesting results.

60. Production of Swan Bands in Discharge through Co.

N. R. TAWDE *and* M. G. K. MENON, Bombay.

In view of the fact that Pretty obtained Swan bands by passing condensed discharge through CO, we tried to produce these bands from CO, using undamped electrical oscillations from a valve oscillatory circuit to excite the discharge. The spectrum in this case, was ,however, found to consist of only CO (Angstrom system). It is known that Swan system is favoured generally at higher pressures and h.f. discharge is not usually possible at relatively high pressures of the order of 2 to 3 mm. of mercury. Consequently, the discharge was excited by damped electrical oscillations using high current density. As a result Swan bands appeared along with some Angstrom bands. To see if Swan bands could be suppressed, pressure was varied and it was found that with pressure reduction, Swan system became weajker and weaker and Angstrom bands of CO became very prominent. Attempts are being made to observe the critical pressures at which one system or the other could disappear.

61. Distribution of Field in H. F. Discharges.

N. R. TAWDE *and* G. K. MEHTA, Bombay.

The distribution of potential between the electrodes of h.f. discharge undergoes considerable change as the pressure of the gas is reduced. At higher pressures, there is an accumulation of positive space charge near the electrodes where the major fal

of potential occurs. At lower pressures the distribution of potential is entirely different. Theoretical considerations regarding the possible distribution of potential before and after the striking of the discharge agrees well with our observations on h.f. discharges. The fact that it is unnecessary to postulate any other ionisation mechanism than that due to electronic collision and that there is small loss of carriers due to the oscillating field, make the study somewhat simpler but interesting. Our experiments in this direction throw much light on the mechanism of the discharge.

62. Study of Polarisation of Fluorescence in Dye-stuffs.

N. R. TAWDE *and* N. RAMANATHAN, Bombay.

The polarisation of fluorescence of dye-stuffs in solution has been investigated in terms of the viscosity, concentration and temperature effects. The dyestuffs for which so far no observations are available, have been chosen for the study. Large number of cases of variations in polarisation are generally in accordance with results of previous workers. But some cases of divergence have also been noted. These cases of divergence are being more thoroughly investigated and examined in the light of the recent theory of Vavilov.

63. Note on the limiting mass of a rotating white dwarf.

G. BANDYOPADHYAY.

Chandrashekhar has proved that the mass of a white dwarf star cannot exceed a certain limit. The present note examines if this condition is changed when the white dwarf has a rotation. Investigation of cases where the rotation is not very large (which would imply rotations slower than thousand times the roation of earth) it is proved that there exists an upper limit to the mass of the rotating white dwarf which is exactly identical with Chandrashekhar's limiting mass. It is further shown that the masses of the rotating white dwarfs approach this limit from below.

SECTION OF STATISTICS

PRESIDENT : S. N. ROY, M.Sc., F.N.I.

Theoretical Statistics

1. On the Moments of the Mean Deviation in samples from a Normal population.

S. JANARDANA AIYER, Trivandrum.

The Standard error of the Mean-Deviation η defined by

$$\eta = \frac{1}{n} \sum_{i=1}^{n} \left| x_i - \bar{x} \right|$$

in samples from a normal population has been derived by R. A. Fisher. In this paper, by the application of Characteristic Functions the first four moments of η have been obtained.

2. On a class of Integrals occurring in Statistical Problems.

S. JANARDANA AIYER, TRIVANDRUM.

In many statistical problems integrals of the type

$$I(k\ ;\ n) = \int_0^\infty e^{-\frac{kx^2}{2}} \left[\int_x^\infty e^{-\frac{v^2}{2}} dv \right]^n dx$$

where k and n are positive integers occur. It is extremely difficult to obtain the exact value of this integral and the evaluation of such integrals is usually by means of quadrature. Pearson and Hojo have obtained by quadrature the values of this integral for particular values of k and n. In this paper, a differential difference equation satisfied by $I(k;\ n)$ has been derived, which may be used for its evaluation.

$I\ (k\ ;\ n)$ satisfies the relation

$$\frac{\delta I(k\ ;\ n)}{\delta k} = -\frac{1}{2k} I(k\ ;\ n) + \frac{n}{2k(k+1)} \left(\frac{\pi}{2}\right)^{\frac{n-1}{2}} - \frac{n(n-1)}{2k(k+1)} I(k+2\ ;\ n-2)$$

In particular

$$I(k\ ;\ 0) = \left(\frac{\pi}{2k}\right)^{\frac{1}{2}} \quad \text{and} \quad I(k\ ;\ 1) = \frac{\frac{\pi}{2} - \sin^{-1}\left(\sqrt{\frac{1}{1+k}}\right)}{k^{\frac{1}{2}}}$$

$$I(k\ ;\ 2) = \left(\frac{\pi}{2k}\right)^{\frac{1}{2}} \left[\frac{\pi}{2} - 2\sin^{-1}\left(\sqrt{\frac{1}{1+k}}\right) + \sin^{-1}\left(\frac{1}{1+k}\right) \right]$$

3. On the Moments of Mahalanobis' D_1^2 statistic.

D. P. BANERJI, Mymensingh.

Mahalanobis' D_1^2 statistic is the square of the generalised distance. Here the moments and generating function of the moments have been found with respect to D_1.

4. Bias in Double Sampling Technique.

(Mrs.) CHAMELI BOSE, Calcutta.

The different aspects of double sampling technique have been discussed by the author in *Sankhya*, June, 1943 and in the thirty third session of Indian Science Congress 1946.

The present paper works out the bias in some of the different sampling procedures involved in double sampling technique. This bias, found to exist for some types and sub-types of double sampling technique, is due to certain constraints implicit in those types and sub-types.

5. An Application in the Multiple Factor Analysis.

P. K. BOSE, Calcutta.

In " Studies in Educational Tests No. 3 "published in *Sankhya*, Vol. 1, the authors tried Spearman's "Two Factor Theory' for the analysis of marks in different subjects in the School Leaving Certificate Examination of the United Provinces for 1919. But as the various tetrads combinations $t_{\alpha\beta\gamma\delta}$ differed significantly from zeroes, the method failed.

In this paper an attempt has been made to use Thurstone's method of "multiple factor" for the analysis of the above data. It may be mentioned that the tests are no properly standardised mental tests, so the interpretation of all the factors is not possible.

6. An Approximate Method for Grouping the Characters in Anthropometric Measurements.

P. K. BOSE, Calcutta.

The B-coefficient defined by Holzinger may be written as

$$B(u) = 200(n-p)S/(p-1)T$$

where the symbols on the righthand side have their usual significance. This coefficient has been used to group the characters on the basis of their inter-correlations. The grouping begins by selecting two characters which have the highest correlation, to this is added the variable for which the sum of the correlations with the preceding is highest Continuing the above process we can finally fix up the groupings.

In anthropometric measurements we measure various characters. If we can make suitable groupings of these characters by a study of their inter-correlations then for the final statistical analysis we can considerably diminish the number of characters by taking one or two characters from each group.

The sampling distribution of B (u) is not yet known but still using the B-coefficient we can approximately group the characters.

7. On the Inadequacy of Measuring the Peakedness of a Distribution curve by the Standardised Fourth Moment.

M. C CHAKRABARTY, Dacca.

The common practice of determining the peakedness of a distribution curve in relation to the corresponding normal curve by the standardised fourth moment β_2 is known to be defective but the *gegenbiespiels* cited are rather pathological in character and may seen to be feats of mathematical gymnastics. The paper demonstrates by the distribution curves of simple statistics derived from well-known population that the peakedness of the distribution curve in relation to the corresponding normal curve an not be determined by the sign of $\beta_2 - 3$,

8. On the Missing Plot Technique.

ANUKUL CHANDRA DAS, Calcutta.

By Fisherian technique we are to find out the sum of squares due to error and that due to treatment plus error by putting some unknown algebraic quantity (Y) for the missing values; taking their minimised values with respect to Y's their estimates are obtained. Here it is shown that the Fisherian technique will ultimately lead to the same result as would have been obtained by the general theory of the analysis of variance without taking the missing plots into account at all.

9. The Analysis of Variance in a Multivariate case.

ANUKUL CHANDRA DAS, Calcutta.

For a p-variate case the sum of p variates with certain weights are taken to represent a resultant univariate. The F or t^2 is calculated and maximised with respect to the combining weights to give the multivariate generalisation. Hence follows:

Theo. 1. The multivariate generalisation of F for two spaces of rank n_1 and n_2 is given by the p roots of the determinantal equation same as in the case of the p statistics when the sample co-variances between any two variates are given by their sum of product per d. f. along those two spaces. For $n_1=1$ F/P is the same as the D_1^2 statistic.

Theo. 2. In the normal case the p roots F of Theo. 1. follows the distribution of p statistics with degrees of freedom equal to the rank of the two spaces and for $n_1=1$ F/P follows the D_1^2 distribution with n_1 d. f.

The more general case than the double classification can be arrived at as a corollary.

10. On the Canonical Multiple and Partial Correlations.

ANUKUL CHANDRA DAS, Calcutta.

Starting from the concept of multiple and partial correlations, certain generalisatons have been made.

Applications of these generalised co-efficients have been discussed in various problems in statistics.

11. Double Sampling with Many Auxiliary Variates.

BIRENDRANATH GHOSH, Calcutta.

The various applications of the technique of "double sampling" with *one* anxiliary variate have been discussed by Cochran (1939). The most usual method is to take a small sample of size n in which the variate to be estimated y, and auxiliary variate x, (linearly correlated with y) are recorded. In a second sample of larger size N only x is recorded, which is easier to enumerate than y. The estimate for the mean value of y in the population is given by $y=a_n+b_n(\bar{x}_N-\bar{x}_n)$, where a_n, b_n and $\bar{x}_n$ are estimates from smaller sample and $\bar{x}_N$ is from the larger sample.

If instead of a single auxiliary variate x, we take k variates of the same type x_1, $x_2, \ldots x_k$, the estimate will be given by

$$y=a_n+\sum_{i=1}^{k} b_i(\bar{x}_{iN}-\bar{x}_{in})$$

It can be easily shown that this will be an unbiased estimate and its variance, will be given by (with large sample approximations)

$$\frac{\sigma_y^2(1-R^2)}{n}\left\{1+k\left(\frac{1}{N}+\frac{1}{n}\right)\right\}+\frac{1}{N}\left(\sum_{i=1}^{k}\beta_i^2\sigma_i^2+2\sum_{i=1}^{k-1}\sum_{j=i+1}^{k}\beta_i\beta_j\sigma_i\sigma_j\rho_{ij}\right)$$

where σ_i^2 is the variance of x_i, ρ_{ij} is the total correlation coefficient between x_i and x_j, β_i is the population value of b_i, R is the multiple correlation between y and $x_1, x_2, \ldots x_k$.

12. Tests of S'gnificance based on Conditional Probability.

H. K. NANDI, Calcutta.

In regression and other problems it is assumed for applying a test of significance that some of the random variables are constant. In fact, this assumption is not necessary when the distribution of the statistic which supplies the test of significance, is independent, on the null hypothesis, of the distribition of the random variables which are held constant—as is the case with the simple and multiple regression and correlation coefficients. The power of these tests, however, will be affected by the distribution of these variables and it has been found in this paper that the t and F tests for simple and multiple regression and coerrelation coefficients retain their optimum properties in a wide class of distributions of the random variables held constant.

13. Sequential Tests of Composite Hypotheses.

H. K. NANDI, Calcutta.

The chief importance of a sequential test lies in the reduction of the average amount of sampling necessary for coming to a decision at a certain level of risks. Such a test is available in testing a simple hypothesis against a simple alternative. In case of composite hypotheses, however, the formulation of a test procedure has been made to depend upon a risk function which does not, in most cases, lead to a solution. In these situations, it is shown in the paper how Neyman-Pearson's optimum critical regions can be utilised in evolving sequential test procedures and what pecuiliarities do they impress on the Operating Characteristic and Average Sample Number curves. It is found that (i) the ratio of the probability distributions of a statistic can be availed of when the statistic is distributed normally with a variance $o(1/n)$ and (ii) the unbiassed critical regions play an important part in controlling the Operating Characteristic and Average Sample Number curves.

14. On the Mean and Mean Difference of symmetrical observations in a sample from a Normal Population.

K. C. S PILLAI, Trivandrum.

In this paper the distributions of $(x_{n-i+1}+x_i)/2$ and $(x_{n-i+1}-x_i)/2$ are obtaind as series, x_i being the i-th observation in an ordered sample of size n taken from a normal population. The rapidity of convergence of the series has been observed by considering the first few terms of the series for different values of n and i.

15. On T-test in ordered samples from a Normal population.

K, C. S. PILLAI, Trivandrum.

In this paper the simultaneous distribution of the centre $M=(x_n+x_1)/2$ and the mean range $W=(x_n-x_1)/2$ is obtained in the form :

$$P\,(M,\,W)=\frac{n(n-1)}{\pi}\,(2/\pi)^{(n-2)/2}e^{-n(W^2+M^2)/2}\,W^{n-2}[F_0(n,\,w)$$
$$+F_1(n,\,w)M^2+F_2(n,\,w)M^4+\ldots\ldots..]$$

where $F_i\,(n,w)$ are functions involving n and even powers of w and x_1 and x_n are the first and last observations in an ordered sample of size n taken from a normal population. The correlation coefficient between M and W is observed to be zero. From P(M.W) the distribution of $T=M/W$ has been worked out. The five per cent levels of significance of T have been calculated for small values of n.

16. Sufficiency and Testing of Composite Hypothesis.

S. N. ROY, Calcutta.

It is well known that a shared sufficient set of statistics for all the parameters of the problem ensures under certain mild restrictions the existence of uniformly most powerful test of a simple hypothesis and vice-versa. The present paper shows that

in the case of composite hypothesis (i) a shared sufficient set of statistics for the free parameters ensures the availablity of valid tests for the fixed parameters of the composite hypothesis, (ii) some further restrictions (discussed in the paper) on the form of the probability density function in the sample space ensure the existence of the most powerful test with regard to any given alternative, while (iii) yet further restrictions in terms of sufficiency (explainned in the paper) ensure that this most powerful test with regard to a particular alternative should also be uniformly most powerful at any rate in a slightly extended sense suggested in the paper.

17. On an Optimum Property of Multivariate Tests obtained from Linear compounds.

S. N. Roy, Calcutta.

In papers offered to earlier sessions of the Indian Science Congress the author discussed the optimum property of the multivariate tests developed earlier by him and and others, in terms of average power, the weightage for averaging over parametric space being often related to Bhattacharya's 'distance function'. The tests themselves, as is well-known, were obtained by a process which consisted in taking a linear compound of the variates, treating that compound as one variate, setting up the corresponding well-known optimum univariate statistics for the different hypotheses, and maximising with regard to the compounding co-efficients thus ultimately leading to quantities defined in terms of the observations (and sometimes also of the hypothesis). The present paper (i) shows that in a certain sense and under certain limitations (explained in the paper) these tests are also locally most powerful and locally unbiassed, and (ii) also discusses the mathematical mechanism by which the 'maximisation process' leads to the optimum property in question.

18. On the exact Distributions of S. S. Wilks' L_{mvc} and L_{vc} criteria for testing hypotheses.

K. Bhaskara Varma, Trivandrum.

The paper deals with a method of deriving the exact distributions of certain sample criteria for testing equality of means, equality of variances and equality of covariances in a normal multivariate population of k variables, on the basis of a sample of size n.

The sample criteria have been developed by S. S. Wilks—by the Neyman-Pearson Method of Maximum Likelihood Ratios and the exact moments of these test criteria, when the hypotheses are true, have also been worked out by him. These moment functions involve Gamma functions; and the exact probability distribution functions are too complicated, except in the cases where $k=2$ or 3. For such complicated cases, approximate distributions have been derived; but there is wide dispartity between the approximate and exact distributions.

In this paper, the exact distributions of Lmvc and Lvc have been obtained from which the values of Lmvc and Lvc corresponding to any given level of significance may be found out with any desired degree of accuracy. The values of Lmvc and Lvc at the 1% and 5% levels for different values of k and n have also been tabled.

Vital Statistics

19. Studies on the Sampling Procedure for a General Health Survey.

K. K. Mathen, Calcutta.

The application of the standard methods of sampling to a general health survey is discussed on the basis of experience gained in the course of the health survey carried out at Singur Health Centre Area under Dr. R. B. Lal. The claim of family as the unit of sampling is examined. Circumtances which disturb the randomness of a sample are given. Chief among these are the biases introduced by the absence of people at the time of survey and refusal of certain sections of the population to submit to certain clinical examinations. The inaccuracy introduced by the forgetfulness of the subjects with regard to history of sickness during the previous year, is also studied. Certain corrections for these inaccuracies are suggested.

20. Decrease of Sex-ratio in order of Birth.

N. T. MATHEW, Calcutta.

A study of the records of the age composition of about 500 working class families from Bengal reveals that there is a steady decrease in the proportion of male children when the order of brith increases; the sex-ratio among first born being 57.4 and the ratio among children of birth-order nine and above being 45.5. It has been shown that the downward trend is statistically significant. The result has been confirmed using published pedigrees from other countries.

21. Statistical study of the influence of age, height, weight, diet, marital status, and religious community of persons on their blood pressure.

N. T. MATHEW, Calcutta.

In this paper which is based on detailed measurementsof 2,800 persons from Bengal, the relation between blood pressure and the above-mentioned factors have been analysed. It is shown that systolic pressure increases steadily from age 8 reaching a maximum at about age 19. Thereafter there occurs a slight fall and from age 25 onwards there is probably a very slow increase. It is doubtful whether diastolic pressure has any progressive trend with age. There is fairly high correlation between blood pressure and weight, the co-efficient being 0·19. The correlation between blood pressure and height is small but positive. There is an apparent difference between the average blood pressure of Hindus and Muslims, Hindus having higher blood pressure but on closer examination this difference is seen to be due to factors other than community. Contrary to previously reported results, vegetarians show higher blood pressure than non-vegerarians. Among Hindus married persons appear to have higher blood pressure than un-married persons before the age 28 and lower blood pressure after that age. Among Muslims married persons appear to have higher blood pressure than un-married persons at all ages.

22. The Problem of Statified Sampling in Human Population.

S. JANARDAN POTI, Calcutta.

In economic enquiries as well as in vital statistics problem, the problem of estimation of the number of individuals possessing a certain specified character in a given population often becomes necessary . If the total population is scattered in the form of units or groups of varying sizes over the area which the population inhabits and the number of individuals inhabiting each of these is known apriori, as is the case of village population, the method indicated in this paper can be very fruitfully employed in the designing of sample surveys.

Economic Statistics

23. Improvement in the economic condition of the Bengal cultivators as a result of Debt Conciliation Act.

D. M. GANGULI, Calcutta.

The Debt Conciliation Act was passed by the Govt. of Bengal in 1935-36 to give relief to the agriculturist and it is believed that their economic condition improved as a result of this. To examine this point figures for the arrivals of jute into Calcutta were examined. It is presumed that if the economic condition of cultivators had actually improved, their holding power also must have increased and comparatively less jute, the most important cash crop of Bengal, would be sold during the first part of the year. Such decrease in sale may also be due to fall in prices. As figures for actual sale are not available arrival figures for periods 1922-23 to 1928-29, 1929-30 to 1935-36 and 1936-37 to 1942-43 and prices of raw jute for the same period were examined for the purpose.

It was found that there was a heavy fall in prices during the second period as compared to the first and the seasonal for the arrival figures for the second period had a significant shift towards the right as compared to the first. This is as we expected. Prices again rose during the third period as compared to the second but there was no

shift between the seasonals of jute arrivals for these two periods showing that the holding power of the cultivators have actually increased and the two opposing forces—high prices and improved economic conditions—counterbalanced each other.

24. Trend of bullion prices in India and abroad.

T. GHOSE, Calcutta.

During the past few years the increase in bulliom prices in India has surpassed all previous records with the result that Indian prices stand at a very high level in relation to prices ruling at important bullion centres of the world. The reason for this have been fully discussed. Production, stock and prices of bullion, especially of silver, have been analysed. Attempts have also been made to estimate the future price structure of silver but it should always be remembered that such an estimate is never complete due to the presence of the three unknowns in the demand curve for silver viz., (1) future hoarding of silver in India, China and other Asiatic countries, (2) U.S.A. 'silver bloc' future position and (3) future industrial use of silver with the advent of the atomic age.

Correlation between total production of gold and world economic activity demonstrates that the total activity is expanded at the rate of 4% per annum while the rate of gold output has varried between 2 to 3%. The tentative conclusion is that unless gold production is brought in alion with economic activity there is little likelihood of a fall in gold prices from its present height; or unless gold is completely thrown out of influence from the field of monetary mechanism of the world.

The discussion has been pushed a little further to ascertain whether International Monetary Fund should stabilise world silver prices by buying and selling silver at fixed price in terms of dollar or of gold to bring about monetary and exchange stability of the member nations.

25. A statistical analysis of Family Budgets relating to subordinate Government servants in Trivandrum.

N. GOPALAKRISHNAN NAIR *and* R. NELAYUDHAN NAIR, Trivandrum.

A representative sample of the family budgets of sub-ordinate Government servants in Trivandrum has been analysed with a view to ascertaining how the total expenditure of a typical family is distributed under various heads. The total expenditure under different heads per equivalent adult have been calculated for each family and the budgets are classified into four expenditure groups based on the total expenditure per adult. The regression of each item on the total expenditure has been measured for all the groups separately to verify Engel's Law of Expenditure. The relative urgency of each item of expenditure in a family has been dertermined for the different expenditure groups separately.

The coefficients of variation in expenditure on different items, the income elasticity of demand for the various items and the correlation between expenditures on different food groups have been calculated for all the expenditure groups and relevant inferences drawn.

26. A formula for the cost of living index of a class for a region.

A. R. SEN, Lucknow

This paper attempts to build up a formula for the cost of living index for a region based on the cost of living indices for the various homogeneous sub-regions.

A definition of homogeneity of the sub-regions have been given and the estimate and the error of the estimate have also been given. Even if the sub-regions are not homogeneous, the best estimate has been worked out.

Agricultural Statistics

27. Crop estimation in India.

D. M. GANGULY, Calcutta.

Acreage under a crop and its rate of yield are two factors which go to build up the total outturn of the crop. In temporarily settled areas of India, the acreage figure

is collected through the Patwaris, which is considered to be reliable and the higher values of the trade returns over the official estimates are attributed to errors in officiel estimates of yield rate, which are considered to be underestimates. But the work of of Dr. Panse in C.P. and Berar during 1944-45 and 1945-46 show that the official yield rate estimates are almost always higher than the actuals. This definitely shows that acreage figures as collected by the Patwaris are gross under-estimations (which in certain cases may be even as wide as 38 p.c.). Among the permanently settled areas, it is in Bengal only that the problem was successfully tackled by Prof. Mahalanobis by a random sample method. Figures for jute show that the estimates of Prof. Mahalanobis differed from the actual based on trade returns by 3·6% in 1944-45 and by 0·3% in 1945-46.

The technique of determining the yield rate by random sample method has been more or less successfully developed by different Institutions in India. A wider application of these methods is the only necessity in this direction. But in case of area estimation no improvement worth its name has been done except in Bengal and the facts already stated show that the figures collected by methods other than those based on random sampling are of extremely doubtful accuracy. Random Sample Method which has been successfully applied in Bengal may be tried in other tracts also, and in the temporarily settled areas the services of the Patwaris themselves may perhaps be utilised for this purpose.

28. Statistics relating to rotation of crops in Bengal obtained as a bye-product of sample survey of crop acreage.

N. T. Mathew *and* Amalendu Ganguly, Calcutta.

In the sample surveys conducted in Bengal by the Indian Statistical Institute during the years 1944 to 1947 for estimating the acreage under diffirent crops, a certain proportion of grids have been kept unchanged from season to season. These grids have been used in the present paper to study the pattern of distribution of land under different crops, and also the changes in this pattern from season to season. Interesting results have been obtained for the two districts Noakhali and Rangpur.

29. Relation of 'border-bias' to size of cut in crop-cutting experiments.

N. T. Mathew, Calcutta.

Among the many problems which arise in the development of a practial sampling technique for the estimation of yield-rates of crops, the problem of ascertaining the most suitable size of sample-cut is a very important one which has not yet been fully solved. Considerations of cost and convenience make it desirable to use a small-size cut, but the need of avoiding bias (which is found to be associated with very small sizes) makes it imperative to use a size large enough for the purpose. The experience of the Indian Statistical Institue has been that with sizes of about 100 sq. ft. and over border bias does not exist in the case of crops like jute, paddy, wheat, barley etc.

In the present paper the results of a series of crop-cutting expriments conducted on jute in Bengal in September and October 1947 with different sizes of cut are given. It is seen that for the jute-corps, bias vanished even with cuts smaller than 100 sq.ft. Some of the results of crop-cutting experiments in previous years are also given.

Educational Statistics.

30. A note on the Reliability of Tests.

P. D. Shukla, Simla.

The usual formulae for evaluating the reliability of psychological tests(Intelligence Tests, Aptitude Tests etc), are time taking. From practical point of view it is necessary to have a formula which gives the reliability quickly and approximately. One such formula has been worked out in this note which gives the reliability $\rho = \frac{\sigma -}{\sigma}$ where σ is the standard deviation of the test.

It is also shown in the note that a fairly big test, whose reliability-coefficient is 0·5, is not good for use and must be rejected.

Industrial Statistics.

1. Statistical Control of Yarn Quality in Textile Industry.

G. D. MATHUR *and* B.SARKAR, Ahmedabad.

The paper shows the possibility of statistical control over yarn quality in textile manufacture.

In a ring spinning frame, it is not possible to be get the desired count with one set of machine adjustments. Average count varies from time to time and constant adjustment is necessary to bring the average count very near to the desired value subject to the condition that the average count can be altered by a fixed amount by every turn of the machine wheel. The minimum size of the sample for the detemination of the average, subject to different percentages of risk is considered. It is found that the size of the sample n should be given by

$$n=\frac{4\sigma^2}{u^2} \quad \text{subject to 5\% risk}$$

where $\sigma=$ the population S. D. of count

$u=$ the unit amount by which the machine count can be altered.

Control limits have been found on the basis of 5% risk for any group of machines spinning a particular count.

The paper also discusses control chart on variation in count, routine checking of "Between day" and "Within day" variations in count. This also shows a method of comparing as to how much variations are being added up in individual spinning processes so that any variation, significantly higher than normal, at any stage, can be removed. The same method is shown to be useful for the comparison of variations added up in different processes, in different mills or in different sections of the same mill.

32. A Note on the Location of Industries in India.

D. V. RAJALAKSHMAN, Madras.

Although various factors have to be considered in studying the regional distribution of industries, statistical measures adopted to estimate the degree of concentration are based only on the figure of industrial employment. Different ratios are evolved to measure the location of industries taking into consideration the industrial population of the country and workers employed iu different industries. Since the war has influenced to some extent the employment position in different industries, an attempt is made in this paper to study the regional concentration of the important large scale industries in different provinces in India after the war by taking the employment figures for factories in 1945.

Defining the location factor for a given industry in a given region to be the ratio of the percentage of the national total of the given industry to be found in that region to the percentage of all industry in the region, these ratios and the coefficients of localisation are calculated for all provinces and for different industries. The effects of the changes in employment on location for some important industries are also studied in this paper by comparing with the situation before the war.

SECTION OF ZOOLOGY AND ENTOMOLOGY

PRESIDENT : PROF. A. B. MISRA, D.Sc., D.Phil. (Oxon.) F.Z.S., F.R.E.S.

---

1. Occurrence of *Isospora dirumpens* Hoare in the intestine of the grass snake, *Natrix piscator*, at Muteswar.

H. N. RAY *and* HARBANS SINGH, Mukteswar-Kumaun

The occurrence of *Isospora dirumpens* Hoare, has for the first time been reported from the grass snake, *Natrix piscator*, in India at a height of 7,500 ft. above the sea level. The type species was reported from the puff-adder, *Bitis arietans*, occurring in Entebbe, Uganda.

The site of infection and the structure of oocyst compared well in all respects with that of I. *dirumpens* except that in the majority of sporocysts the residual body presented a scattered appearance rather than a compact mass as described by Hoare in 1933.

2. On a collection of Cestodes from marine food fishes of Trivandrum coast.

P. RAMAVARMA RAJA, Trivandrum.

There are numerous species of Nematodes, Trematodes and Cestodes occurring as internal parasites in marine food fishes of the Travancore coast. Of these Trematodes and Nematodes are very prevalent, while Cestodes have , so far, been found to be represented only by three species and three larval forms. *Tetrarhynchus herdmani*, Shipley and Hornell 1906, is now recorded for the first time from the intestine of a shark (*Chiloscyllium*) the previous record having been only from *Rhynchobates djddensis* and *Dasybates Walga.*

Cephalobothrium abruptum Southwell, 1911, was found in the spiral valve of *Pteroplatea micrura*. The host was heavily infected and contained one hundred and twelve specimens. *Gymnorhynchus malleus* (Linton 1924) is a parasite in the spiral valve of *Pteroplatea micrura*. Though the general characters of the specimen now collected, namely the arrangement of spines, muscle fibres, vitelline glands and eggs conform with the description of the type specimens, the head is much thinner and shorter.

The larval forms include a collection of Plerocercoid larvae, larvae of *Gymnorhynchus* and cysts of *Tetrarhynchus*. The Plerocercoid larvae were obtained from the mesentary of *Trichiurus savala*. Since the internal structure of this larva is indistinguishable, it has not been possible to determine the species to which it belongs. The *Gymnorhynchus* larva, also collected from the mesentary of *Trichiurus savala*, evidently belongs to th species *G. gigas*. Two cysts of *Tetrarhychus* were obtained from the peritoneal cavity of *Lutjanus*. This evidently belongs to Vaullegeard's first division of *Tetrarhynchus*, namely *T. lingualis*. Similar cysts have been previously described by Shipley and Hornell from the peritoneal cacity of *Balistis mitis.*

3. Tube building organs of Polychaetes.

P. R. SADASIVAN TAMPI, Madras.

Dalyell's account (1853) of the tube building habits of polychaetes has been mainly responsible for the wide interest among naturalists on this sybject. A few of the common tubicolous polychaetes like *Diopatra, Dasychone, Hydroides, Sabellaria, Chaetopterus, Phyllochaetopterus, Loimia, and* and *Nicolea* have formed the subject for this study and observations have been made on the process of tube construction. The position and structure of the building organs and of the glands concerned in tube building have been determined. The structure of the tube building organs depends on the nature of the

materials with which the tubes are formed. Sabellids usually possess a complex building organ at the base of the branchial crown where fine mud particles are stored, mixed with mucus secretion and passed out in the form of strings between a pair of parallel folds. In the Sabellarids and Terebellids where the tubes are composed of sand grains, they possess accessory structures with great manipulative capacity. All the tubicolous polychaetes possess glands usually situated on the ventral side of the anterior part of the body which are capable of secreting large quantities of mucus, helping in the formation of the tube. These glands are usualy groups of secretory cells which may be distinguished from the simple ectodermal gland cells. The various adaptation for tubicolous life also mentioned and discussed.

4. Genital papillae (suckers) and Sperm-sacs in the pisionid Polychaete, *Pisionidens indica* (Aiyar & Alikunhi).

K. H. ALIKUNHI, Madras.

A detailed account of the unique plychaete *Pisionidens indica* was given by Aiyar and Alikunhi (1940, 43). The present communication embodies the results of studies on the developmental history of such accessory structures in the male as the genital papillae (Suckers), the sperm-sacs and the copulatory organs.

The genital papillae (suckers) make their appearance only when the worm attains sexual maturity. Their resembalnce to the ventral suckers of Blepharocerid larvae is striking. Full details of their structure and working are given.

With the formation of the rudimentary genital funnel in apposition with the nephridial swolling, the distal portion of the nephridial duct gets hypertrophied and surrounded by a thick muscular sheath. The cells of the nephridial duct in this region get loaded with numerous refractile granules. The copulatory organ is formed *de novo* as a prologation of the body-wall at the base of the ventral cirrus which gets flattened and foliaceous. The nephridial duct opens at the tip of the copulatory organ which is completely retractile.

The homology of the sperm-sacs and the copulatory organ is the same as in the allied genus *Pisione*(Alikunhi, 1941 & 1947)

5. On *Anophthalmus* (Fam : Hesiondae)—A new genus of Polychaetes with descriptions of four new species from the sandy beach of Madras.

K. H. ALIKUNHI, Madras.

In the course of an investigation of the fauna of the sandy beach, Madras, several minute, blind Hesioned polychaetes were found to be fairly common in the inter-tidal sand. The present communication embodies descriptive accounts of four new species, all belonging to the new genus *Anophthalmus.*

Anophthalmus gen nov. :

Minute blind worms, with 12 to 40 segments ; head with three antennae, two palps and three pairs of tentacular cirri ; cirri without basal articles ; parapodia biramous ; dorsal bristles simple ; ventral setae compound ; anal plate either entire or bifid ; with two long anal cirri ; pharynx with a crown of papillae but without jaws ; and sexes separate.

Anophthalmus erythraeus n.sp. and *A. splendens* n.sp. differ from each other in the relative size of the tentacular cirri, in colouration and in the stricture of the anal plate. *A. longicirrus* n. sp. is closely related to *A elegans* n. sp. from which it differs in colouration, relative size of tentacular cirri, nature of setae and the anal plate.

Full descriptions of the species are given together with a discussion on their relationships.

6. Osmoregulation in penaeid prawns.

N. KESAVA PANIKKAR, Madras.

In continuation of the studies on the osmoregulation of Palaemonid prawns, (Journ. Mar. Biol. Assoc. U. K. Vol. 25, 1941) investigations have been made on the adaptation and osmotic behaviour of three penaeid prawns of commercial inportance on the Madras

Coast. viz. *Penaeus indicus*, Milne Edwards, *P. carinatus* Dana and *Metapenaeus monoceros* Fabricius. These species are well known for their tendency to migrate into estuaries and backwaters and their adaptational powers have been experimentally studied together with corresponding observations on the salinities of their natural habitats. Of the three species *Metapenaeus monoceros* is the one which can survive the highest salinity ranges both low as well as high i.e. from about 3 per mille. to 50 per mille. Less tolerant to low salinities is *P carinatus* where as *P. indicus* has a comparatively limited range as it dose not survive in the low and high salinities tolerated by either of the above species. Preliminary studies based on cryoscopic data seem to indicate that *Metapenaeus monoceros* is slightly hypotonic to the external medium while it is in normal sea water but that there is pronounced hypertonicity in lower dilutions. These results have been checked with parallel studies on the retention of Chloride in various dilutions. The significance of these results on the distribution of these species and the general problems of osmore-regulation is discussed.

7. Observations on the habits of Stomatopods.

K. H. ALIKUNHI, Madras.

Though one of the characteristic groups of the tropics, very little is known about the life habits of stomatopods. Observations on the larval, post-larval and adolescent forms of several species of the genera *Squilla* and *Lysiosquilla* were made in aquarium tanks at Madras.

Final pelagic larvae moult and metamorphose into post-larvae overnight in the laboratory. The exact process of moulting and the rapid assumption of post-larval features are fully discussed.

The transparent pelagic larva rarely has any chromatophores on the body. On metamorphosing into the post-larva chromatophores suddenly make their appearance and get distributed in characteristic patterns. If the larval eye stalks are cut off, the formation of chromatophores is arrested in the resulting blind post-larva, which consequently becomes an albino. Though blind such specimens also thrive in the aquarium and undergo regular moults.

Chatacteristic feeding habits of larval and post-larval forms are detailed in the paper. Cannibalistic tendencies predominate.

8. Note on the metamorphosis of Phyllosoma larvae from the Madras plankton.

K. H. ALIKUNHI, Madras.

Though not very common, Phyllosoma larvae form a conspicuous item of the marco-plankton of the Madras coast, particularly during March. Early stages are remarkably few in the surface plankton, while the final pelagic stage predominates. Puerulus occurs only rarely.

As in the case of Stomatopods, the final pelagic larva metamorphoses into the post-larva, over-night in the laboratory. Early larvae also moult into later stages. The post larval specimens thrive in aquaria and grow by regular moults . The mechanisms of larval and post-larval moults are described in detail.

Larval and post-larval stage of two species of *Scyllarus* and a single species of *Panulirus* are dealt with in the present note.

Correlation of larvae with the adults on direct evidence of metamorphosis is being achieved for the first time in India in this economically important group of decapod crustaceans.

9. Observations on a copepod (*Caligus pterois* SP. NOV.) parasitic on scorpion fish *Pterois russellii* (Van Hass).

C. V. KURIAN, Trivandrum.

Caligus pterois sp. nov. is an ectodermal parasite on scorpion fish (*Pterois russellii*). Attempts were made to induce the parasite on other fishes without success, thus indicating its tendency for a specific host, as in other caligids. The parasite lives on the blood of the host and as such it is found to be detrimental to the host, especially when infection is severe.

A systematic study of the parasite shows that it is a new species which resembles *C. rufimaculatus* Wilson and *C. pageti* Russell in the general shape of the body, but it differs from both these in the structure of the appendages. The mandible is long and slender, having twelve small serrations on the curved inner edge towards the free end. The sternal fork consists of two blade-like processes directed backwards, which are connected at the bases by a narrow bridge. The fifth and sixth pairs of legs are visible dorsally as three small setae on each side at the postero-lateral corner of the genital segment . In male the abdomen is two-jointed, the distal one being three and a half times as long as the small proximal joint.

The reproductive organs of the parasite resembles those of caligids. The egg cases are long , containing about forty to fifty eggs in each string. The eggs are colourless at first but gradually become reddish-brown before it is liberated from the egg case. The embryo on extrusion from the egg case hatches out as a *nauplius* after about an hour. Two naupliar stages have been observed, the later stage being reached within 11-14 hrs. after the issue of the first nauplius. About 20 hrs. after hatching the *copepodid* stage is reached. It swims about in search of a suitable host and clings to it by the second antennae which are large and well-developed as clasping organs. After attachment it passes through four *chalimus* stage. In the last chalimus the sexes can be differentiated and in the male the reproductive organs are visible in the genital segment. At the next moult, the animal gets free from the frontal filament and attaches itself to the host by the lunnules and the clasping organs.

10. Sex diferences in four genera of copepods parasitic on Indian fishes.

P. C. GNANAMUTHU, Madras.

The difference in sex ratio observed among free living copepods is not so marked in forms with a confirmed parasitic habit. Differences in size noticeable among non-parasitic copepods is greatly exaggerated in the more degenerate parasitic forms like Lernaeopodidae, while it is not so marked in the less specialised families like Caligidae. The parasitic males possess not only the prehensile organs characteristic of the species but also special devices for attachment to the females. The reduction in size of the male and greater development of organs of attachment are specially noted in *Bomolochus multisponosa* and *Clavellisa dussumieria*, in which the males are diminutive in size and are attached to the females even after fertilisation. The sex dimorphism of those forms, as well as those of *Lernanthropus dussumieria* and *Caligus polycanthi* are discussed in detail. The sex differences in the Dichelosthid Lernanthropus, cannot be explained as due to parasitism as such but rather as accentuations of differences occuring in free living forms due to gonadal activity. The differences in Caligids appear even in so late larval stages. Sex differences in the parasitic forms, may be due to the males being attached to the females and therefore being less motile, and not because of parasitic feeding, and also due to their sexual efflorescence while still at a low growth level.

11. On the occurrence of Crangonids (Crustacea, Caridea) in the costal waters of Trivandrum.

C. V. KURIEN, Trivandrum.

The Crangonids are bottom dwelling Crustaceans generally found among sea weeds. Two species namely *Pontophilus hendersoni* Kemp, and *P. parvirostris* Kemp, were collected from the Trivandrum coast while investigating the bottom fauna within the fifteen fathom line. The former is represented in the present collection by a few specimens and the latter only by a single specimen.

Though *P. hendersoni* resembles the type specimen in the general shape and specific characters, certain remarkable differences have been observed in the structure of the appendages. The thump of the sub-chela in the first peraeopod is about twice the length across its base and resembles that of *Philocheros megalocheir* Stebbing. The second peraeopod has the fingers more than double the length of the palm and the constrictions at the apices of the fingers are very indistinct. The size is comparatively large, being about double that of the specimens collected from the Chilka lake. It also possesses a remarkable colour pattern.

The affinity of *P. hendersoni* with *P. megalocheir* is only superficial ; the latter can be easily differentiated by the distinctive characters of the appendages.

P. parvirostris also shows certain differences from the type specimen described by Kemp. The thumb of the sub-chela which is longer, the proportionate lengths of the joints of the first peraeopod differ and the sixth abdominal somite is slightly smaller than the telson.

12. On two new species of Crabs from Travancore.

N. KRISHNA PILLAI, Trivandrum.

This paper gives a brief account of two new species of crabs collected while investigating the crab fauna of the State.

Huenia. sp. nov. belongs to the sub-family Acanthonychinae in the family Maiidae. The species can be easily distinguished by the following characters. (1) In front of the gastric tubercle there are two additional dorsal tubercles. (2) The lateral expansions of the carapace are not so foliaceous as in *H. proteus*. (3) The rostrum instead of being simple and laterally compressed, shows a distinct flattening on its ventral side ending in a spoon shaped tip. (4) There is no distinct pre-ocular spine, but the presence of a supra-ocular ridge together with an ill developed pre-orbitary tooth gives the impression of an orbit. This species usually lives among weeds on the submerged rocks and boulders within tidal limits in south Travancore.

Macrophthalmus sp. nov. belongs to the sub family Scopimerinae of the family Ocypodidae. It differs from all known species of *Macrophthalmus* and according to the key given by Tesch (1915) it comes between *M. dilatatus* and *M. brevis* resembling the latter to some extent. It lives on the mud flats forming the shore of the back-waters in certain regions of the Ashtamudi and Vembanad lakes and is usually found along with *Gelasimus marionis* and *Dotilla myctiroides* and other inhabitants of the mud flats.

13. A collection of Pycnogonids from the Vizhinjam coast.

C. V. KURIEN, Trivandrum.

This paper discribes four species of Pycnogonids collected from the Vizhinjam coast within the 15 fathom line, during a survey of the bottom fauna and botttom deposits of the region. Though previously pycnogonids have been obtained in the plankton collection (Menon 1945), they are essentially bottom-dwelling animals, generally found among sea weeds. Of the four species in the present collection, *Parapallene kempi* Calman is the only common species the other three are either rare or only casual visitors in this locality.

Pallenopsis sp. resembles *P. alcocki* Calman and *P. crosslandi* Carpenter in general appearance , but it differs from both in the structure of the finger-like processes on the legs and the abdomen. Each process bears 4-5 small spines on its sides and free end in addition to the long spine at the tip.

The specimens of *Anoplodactylus cribellatus* Calman, differ from the type in having the second coxa of the third leg slightly shorter than the first and the third joints together, and in having the basal projection on the propodus not strongly marked.

P. kempi is previously known from the Orissa coast, Gulf of Mannar and Waltair and *A. cribellatus* from Andamans. *A. petiolatus* has been hitherto collected oniy from the European coast, Mediterranean and Pacific and is recorded from Indian water for the first time.

14. Anopheles breeding in the rice-fields of lower Bengal.

P. SEN, Calcutta.

Eleven apecies *A. hyrcanus* var *nigerrimus*, *A. barbirostris*, *A. annularis*, *A. ramsayi* *A. pallidus*, *A. philippinensis*, *A. tessellatus*, *A. varuna*, *A. aconitus*, *A. vagus* and *A. subpictus*, were found to breed in the cultivated rice fields. Turbidity had no adverse effect on the last two species which were practically the only anophelines that bred in fallow fields.

A. hyrcanus aand *A. annularis* appeared in the rice fields with the introduction of Seedlings, but they bred more intensively towards the close of the season when the water had stagnated.

A. pallidus, *A. philippinensis* and *A. varuna* although of low prevalence, indicated preference for breeding in fields with tall plants usually 1′ in height when the water was clear.

The maximum amount of breeding in the rice-fields was noticed at 2″ to 6″ column of water, diminishing gradually after this.

The only important vector species in the area *A. philippinensis* although of very low prevalence being below one per cent of the total catch in larval stage, was recorded

from a range of ½" to 1'6" of clear water when the plants had grown 1' to 2' tall ; *A. varuna* required a larger volume, the minimum being 1" and maximum 2'.

From 1' to 2' tall plants gave the best range for the development of the various anopheline larvae ; and beyond 2'6" stage of rice plant the important species became scarce.

15. Ecological studies on *Odontotermes redemanni* Wasmann.

D. MUKERJI *and* PRABHAS KUMAR MITRA, Calcutta.

Situations of the nests and infestations by this species have been studied. The range of pH of the fields infested by this species, in the dam areas of Maithon (Barakar), is from 6.4 to 7.0, the average being 6.6 The structure of the termitarium with special reference to the fungus-combs has been studied . The pH of the fungus-combs varies from 3.9 to 4.3, the average being 4.06. The relative proportion of the soldiers, workers and immature forms calculated roughly, indicated the ratio to be 1:6:33. The colonising activities of this species has been studied.

16. Post-embryonic development of antenna of *Bagrada picta* Fab.

S. S. SAXENA, Gwalior.

Almost all the members of the family Pentatomidae (Hemiptera-Heteroptera) possess five -jointed antennae ; similarly *Bagrada picta* Feb. also has five-jointed antennae in the adult stage. But during the nymphal stages the antennae remain four-jointed. It has been seen that during the nymphal stages the pedicel continues to elongate much more rapidly than other segments of the antenna, but in the adult stage it becomes shortened, while segments continue to elongate as in the previous stages. The natural inference would be that the pedicel becomes divided into two segments and thus becomes shortened. In fact it actually happens, viz. , a new segment appears in the adult stage and thus the antenna becones five-jointed which was so far four-jointed.

Hence it may be concluded that in *B. picta* Fab., it is the pedicel only which divides and thus a new segment is added to the antenna.

Now it can be generalised that wherever there is an increase in the antennal segment it is only the pedicel which divides.

17. On the Occurrence of an interesting species of Shrimp-fish (Centriscidae) from Travancore Coast.

S. NATARAJ, Trivandrum

In March 1947 three collections of Shrimp-fish were obtained in the *Nonnavu madi*, a close meshed shore seine net used periodically for the fishing of post-larval forms of fish, Crustaceans and Cephalopods. The collection is particularly interesting because it represents a hitherto undescribed species of Shrimp-fish belonging to the genus *Centriscus* and because this is the first record of the occurrence of any species of this genus from the Travancore coast.

So far only two species of *Centriscus* are known from the Indo-Australian waters (Weber and Beaufort 1942) viz. *C. scutatus* L. and *C. cristatus* (De Vis). Of these the former appers to be a more common species since it has been recorded from different places in the Indian Ocean other than the West coast of India, while the latter is restricted more to the Australian than Indan seas.

The present examples differ from the above two species in a number of characters, the chief of them being the presence of a small strong hook which originates a little distance below the tip of the backwardly directed dorsal spine and the presence of a pair of small curved sharp spines from the anterior end of the lower lip. These characters are not found in any known Indo-Australian species of the family Centriscidae. A detailed account of the species is under preparation.

18. The Molluscan Fauna and the Lime Shell Resources of Travancore.

K. PARAMESWARAN PILLAI, Trivandrum

The present paper is based on an extensive collection of shells from the different backwaters of the State and from the sea coast. The collection includes fortyfive species of Lamellibranchiata belonging to twenty-seven genera and eighty-two species of Gastro-

poda belonging to forty-two genera. Of this large collection only three genera of Lamellibranchiata constitute the main source of lime (calcium carbonate). *Meretrix* and *Velorita* are the chief groups represented in the backwaters where they form extensive clam beds and rich subsoil deposits. *Arca granosa* shells are also found in the subsoil clay in the south eastern part of the Vembanad Lake. Large quantities of miscellaneous shells are drifted ashore during the south west monsoon by the strong south-easterly current which strikes the coast of Munampam, Kayamkulam and Quilon.

An attempt has been made to study the bionomics and distribution of the important species and also to determine the calcium content of the representative types. It has been found that the percentage of calcium carbonate in *Arca granosa* and *Velorita cornuco* been dound that the percentage of calcim carbonate in *Arca grnnaa* and *Velorita cornucopia* is 95.35 and 94.8 respectively while that of *Ostrea madrasenis* is only 91.50 This is probably the reason why the shells of *Ostrea* are not used for the manufacture of lime though they are plentiful in some of the back waters.

19. A further note on the Breeding, Parasitism and Development of the Indian Freshwater Mussels.

R. V. SESHAIYA, Annamalainagar.

Lamellidens marginalis attains sexual maturity when it is just over two years old, whereas the European freshwater mussel *Anodonta* does not attain sexual maturity till the fifth year of its life. Species of *Lamellidens* seems to have two principal breeding seasons. Gravid females with ripe glochidia in the gills are abundant in the months of July & August, and again in December, January and February. But stray instances of gravid females are occasionally met with in other months. During the summer months, when the ponds dry up, the fresh water mussels burrow into the deeper layers of the mud. Such aestivating mussels include gravid females, i.e., with developing eggs in their marsupia. The following fishes have been experimentally found to be suitable hosts for the glochidia of all the common freshwater mussels :—

1. *Ophicephalus striatus*,
2. *Ophicephalus gachua*,
3. *Ophicephalus punctatus*,
4. *Macrones vittatus*,
5. *Anabas testudineus*,
6. *Etroplus maculatus*,
7. *Ryhnchobdella aculeata*,
8. *Notopterus notopterus*,
9. *Glossogobius giuris*,
10. *Anguilla bengalensis*.

Exotic fish like *Gambusia* were also found to be suitable hosts for the glochidia. After repeated infections (Usually five or six) the fish acquire immunity, and the encysted glochidia fail to metamorphose. Natural immunity is possessed by some fish like *Aplocheilus* and species of *Barbus*. The sequence of organogeny during the parasitic period which is three days in the hot season and six to eight days in the cold season is briefly described.

20. On a collection of Scaphopods (Mollusca) from the Travancore coast.

C. V. KURIAN, Trivandrum.

The paper deals with a collection of scaphopods obtained on a survey of the Bottom Fauna and Bottom Deposits of the Travancore Coast within the 15 fathom line. *Dentallum cancellatum* and *D. paucicontrotum* are represented by solitary specimens from Alleppey at 12 faths. and from Trivandrum at 15 faths. respectively, while *D. quadrapicale* has been obtained sparingly from Trivandrum and Cape Comorin regions. The specimen of *Dentalium* collected, range from 11.9—50 mm. in length. The genus *Cadulus* is represented by a single species, namely *C. longilobatus* which is common at Trivandrum in a deposit formed of black sand with a small percentage of mud and shell fragments, and swarms occur towards the 15 fathom line during February and March.

Of the four species dealt with, only *D. quadrapicale* has been previously recorded from this Coast and that by the Siboga Expedition from a depth of 406 fathoms.

The systematics and distribution of all the species collected are given.

21. The rate of Growth of *Cerithidea cingulatus* Gmelin (Gastropoda Pectinibranchia).

V. SADASIVAN, Madras.

In this paper an attempt is made to study the rate of growth, the duration of the breeding period and the age at maturity of *Cerithidea cingulatus* Gmelin, the common gastropod of the backwaters at Madras. With the data of length measurements of samples of population collected every month, the animals were grouped according to the different size groups. Size frequency curves were drawn for all the months and the rate of growth followed. The rate of growth in the young shells belonging to 1945 genera tion, as indicated by the growth curves, is 1.17mm. per month ; i.e. shells which were 4 mm. in the month of May '45 were 22 mm. by December '46 within a period of 19 months. Rearing experiments perfromed in the Laboratory with young shells measuring 4 mm. showed the same sate of growth as recorded from field observations. Growth seems to cease with the 22 mm. size group. The adult characters of the elevated body whorl and the expaned and everted lip are acquired after one year. Growth in the older shells belonging to the second and third years is very slow and it was found by rearing experiments in the Laboratory to be 0.17 mm. per month. The animals attain sexual maturity when they reach the 18 mm . size and, it is estimated, in about 2½ years after the young ones settle down. Breeding season begins in the month of January and extends till the end of June with a pronounced peak in the month of March.

22. A preliminary report on the Cephalopods of Baroda.

S. T. MOSES, Baroda.

Introduction—Ammonites as 'Saligrams'—*Nautilus pompilius* shells 2 obtained—Shells of Spirula prototypos common—Cuttlebones the 'Samudraphen'-Cuttlebone lease and trade-The edible Cephalopods *Sepia* and *Loligo*—Check list of species of Cephalopods (1 *Sepiola*, 3 of *Loligo*, 1 *Euoploteuthis*, 5 of *Sepia* and 6 of *Octopus*).

23. A preliminary account of the marine planktonic Diatoms of the Trivandrum coast.

P. V. RAMACHANDRAN NAIR, Trivandrum.

The coastal waters of Travancore are rich in planktonic Diatoms during certain seasons of the year, and hitherto forty-one species have been recorded by M.A.S. Menon (Proc. Ind. Sci., XXII, 2. 1945 pp. 36-38). During the present investigations seventy-one species belonging to fourteen families and twenty-nine genera have been collected. Of these sixty-one species have already been described from the Madras coast by Subramanyan R. (Proc. Ind. Acad. Sci. ,XXIV. 4. 1946) while the remaining ten species namely, *Hyalodiscus stelliger* Bailey, *Rhizosolenia shrubsoleii* Cleve, *R. bergonii* H. Perags *Chaetoceros pseudocrinitus*, Ostenfield, *C. borealis* Bailey, *C. brevis* Schutt, *C. sericanthus*, Gran, *C. compressus* Lauder, *Triceratium*(sp) and *Fragilaria striatuk* Lynbys, are recor ded from the Indian coast for the first time. The dominant families of Diatoms in this coast are *Chaetoceros*, *Bidulphia*, *Rhizosolenia* and *Coscinodiscus* while the other families are comparatively rare and are only found occasionally in plankton collections.

A quantitative study of the Diatoms in relation to the phosphate and nitrate contents of sea water and other hydrographical factors is in progress.

24. Limnology of the Mukerti Reservoir, Nilgiris. 1 Summer Conditions.

FRANCESCA THIVY, S. V. GANAPATI *and* K. H. ALIKUNHI, Madras.

The Mukerti Reservoir, situated at an altitude of over 8000 feet, is formed by damming up of the Mukerti river and has a water-speard area of about a square mile with a maximum depth of 84 feet. The exotic Rainbow Trout is the only important food fish stocked in this reservoir.

A hydrobiological study of the reservoir was carried out in March, 1947.

Water is pure, soft and rich bottle green in colour, with good depth of visibility. Temperature ranges from 18.1° C at the surface to 15.7°C. at a depth of 68 feet. pH. varies with depth from 6.3 to 5.9. Water and plankton samples collected from fixed depths reveal the presence of dissolved oxygen only up to 59 feet from the surface.

Marginal vegetation is formed by a dense growth of the dominant species of the 'down flora', i.e., the grass *Cymbopogon polyneuros* Stapf. Phytoplankton is represented by a variety of species of desmids and diatoms. Zooplankton is comparatively poor, copepods and rotifers forming the main constituents.

The reservoir is oligotrophic in character and contains the Caledonian type of phytoplankton.

25. Hydrobiological investigation of the Stanley Reservoir at Mettur, Madras.

S. V. GANAPATI, K. H. ALIKUNHI, *and* FRANCESCA THIVY, Madras.

A preliminary hydrobiological survey of the Stanley reservoir and the Cauvery river at Mettur was for the first time made under summer conditions in June, 1947.

The reservoir level was 94 feet. Water samples were collected from the surface as well as from 34 and 94 feet levels and analysed.Experimental fishing at particular depths revealed that no fish frequented the 40 foot level and below. While the surface water was green in colour and rich in dissolved oxygen with a pH. of 8.5, at 34 feet level dissolved oxygen was nil, pH. 7.5 and sulphuretted hydrogen 1.423 mg/l. In the deeper layers the concertration of this gas increased. However, the black malodorous water issuing out of the tail-race of the Mettur Power House as also the'water trickling down the high and low level sluices contained sufficient dissolved oxygen and had only traces of sulphuretted hydrogen, smelling strongly of the same. Sulphur bacteria (Thiothrix nivea) were thriving luxuriantly all along the course of the discoloured water and fishes like *Labeo kontius*, *Barbus carnaticus*, *Cirrhina* sp. *Danio*, and *Discongnathus* were observed eeding in the area.

The lentic conditions prevailing in the reservoir consequent on the damming of the river facilitate thermal stratification during summer months. Under anaerobic conditions in the lower layers sulphate recduction takes place resulting in the formation of hydrogen sulphide. The accumulation of this gas appears to render over 2/3 of the reservoir uninhabitable for fish. Even before becoming lotic in character the lower layers of water gushing through the sluices get aerated and rendered suitable for both fish and plant life.

26. On the Ecology of two temple tanks at Coimbatore, Madras.

FRANCESCA THIVY, S. V. GANAPATI, *and* K. H. ALIKUNHI, Madras.

Utilisation of religious institutional waters for fish culture is being actively pursued in Madras, and the elucidation of the ecology of this characteristic type of waters is of immediate practical importance. Observations on two such tanks at Coimbatore carried out in July, 1947 are detailed in the present communication.

	VENUGOPALSWAMI TANK.	ANJENEYASWAMI TANK.
Colour of water	Yellowish brown.	Yellowish green.
Depth	13 feet.	10 feet.
Temperature	28·4 to 29·5°C.	26·5 to 28·0° C.
pH.	8·05 to 8·50	8·08 to 8·30
D.O., cc/L.	1·675 to 4·188	1·256 to 4·328
Free CO2	NIL	NIL
Chloride	9·2 parts per 100,000	9·7 parts per 100,000
Macrovegetation	NIL	NIL
Phytoplankton	Chlorococcales dominent, fewer Blue-greens, diatoms, flagellates & Dinophyceae.	Identical
Zooplankton.	Copepods & Rotifers dominant.	Rotifers dominant.
Fish stocked.	*Gourami, Chanos, Catla, Cirrhina reba.*	*Gourami, Chanos, Etroplus, Barbus hexagonolepis.*

Diurnal variations in the two ponds are discussed on the basis of six-hourly observations.

An almost permanent algal bloom is characteristic of the majority of temple tanks. Fish food in such tanks is obviously abundant.

27. On the Ecology of two spring ponds at Conjevaram, Madras.

S. V. GANAPATI, Francesca Thivy *and* K. H. ALIKUNHI, Madras.

The village spring ponds at Rajampet and Muthialpet in Conjeevaram were surveyed in June, 1947. Situated in the midst of arid sandy region, the ponds are fed by deep perennial springs. During the rainy season they got connected to the river Palar.

Local carps, murrels, gobies, catfishes and minnows constituted the existing natural fishery in these ponds.

Conditions of existence during summer were as follows :

Pond.	Depth at the centre.	Colour.	Temperature.	pH.	Dissolved O2	Free CO2.	Chlorides.
Rajampet. ..	4 ft.	dark green.	30·1—31·5°C.	7·1	4 to 6 cc/L.	0·8 0·9 parts per 100,000	17 parts per 100,000
Muthialpet. ..	5 ft.	Bluish.	32·4—32·8°C.	7·5	5·2–7·2 cc/L.	0·37–0·59 parts per 100,000	32 parts per 100,000

Hydrophytes are abundant in both the ponds. Several green and blue green algae are present in the phytoplankton, while the absence of planktonic crustacea is characteristic of the zooplankton.

The perennial springs, low free carbon-di-oxide, high Oxygen content, gently flowing water, absence of planktonic crustacea, etc., constitute important ecological traits which make the ponds a type by themselves, offering scope for pisciculture.

28. Limnology of the Ootacamund Lake, Nilgiris : II. Summer Conditions.

K. H. ALIKUNHI, S. V. GANAPATI *and* FRANCESCA THIVY, Madras.

A detailed limnological survey of the Ootacamund lake was conducted in March, 1947.

Over seventy acres in area and situated at an altitude of about 7000 feet, the lake is now stocked with exotic species like Tench, English carp, and varieties of *Cyprinus carpio,* besides indigenous species of minnows, loaches and barils.

The bottom configuration was charted by taking soundings at 259 points. Maximum depth was 30.6 feet. Water and plankton samples were collected from fixed depths at different stations. Diurnal variati ons in the hydrobiological complex occuring in different layers were investigated at six-hourly intervals. A representative collection of the macrofauna and flora has been made. The rich hydrophytic and halophytic associations were plotted in detail. Bottom deposits from different sections were studied.

A pronounced thermal stratification and the co-existing conditions of summer stagnation prevailed in the lake. Dissolved oxygen extended to a maximum depth of 20 feet. Deeper layers were devoid of oxygen but were surcharged with sulphuretted hydrogen. pH. varied from 6.5 at the bottom to 8.7 at surface. Temperature steadily diminished with depth, from 21.6 to 15.3oC.

Aquatic oligochaetes were present in the oxygenless bottom mud.

Phytoplankton consisted almost exclusively of a dense swarm of *Ceratium hirundinella* which imparted a dirty brown colour to the water. Zooplankton was rich in species and numbers, Cladocerans, Copepods and rotifers predominating. Plankton was absent in the oxygenless zone.

The lake is essentially eutrophic in character. However, the oxygenless zone considerably restricts the effective space for fish life and productivity.

29. Utilisation of Fire Service Tanks for Fish Rearing.

P. I. CHACKO, Madras.

The concrete static tanks intended for fire-fighting purpose, are used for nursing and distributing fish-seed, for stocking larvicides, and for fish production and marketing in Madras. A static tank of 150,000 gallons capacity in Madras City was stocked with 75

fry of *Labeo rohita*, 3500 of *Catla catla*, 10 of *Gourami*, and of 100 *Etroplus suratensis*, and with 500 *Gambusia affinis* in July-August 1946. Water plants were planted, and manuring was also done. The plankton of the tank consisted of *Anabaenopsis*, *Ceratoceros*, *Closterium*, *Copepods*, *Cyclotella*, *Euglena*, *Lyngbia*, *Melosira*, *Microcystis*, *Navicula*, *Oscillatoria*, *Pandorina*, *Phacus*, *Rotifer*, *Spirulina*, *Synedra*, *Surirella*, *Volvox* and Vorticellid colonies. In November 1946, 3000 Catla, 8-10 inches in size, were removed for stocking other waters. In January 1947, 20 Rohu, 12-14 inches, were also removed for the same purpose,. 34 Rohu, 14-18 inches and 2-3 lbs, were netted and marketted in June 1947. Gourami (9-12″) and Etroplus (4-6″) were collected and stocked in another breeding pond. The static tank was then cleaned, dried and refilled in July. During cleaning, one *Geoemyda trijuga* and one *Anguilla bengalensis* (36″ and 3 lbs) were removed. The stomach of the latter contained fish remains and algal matter.

30. An Investigation into the Food and Feeding Habits of some of the common Freshwater Fishes of Madras.

K. H. Alikunhi *and* S. Nagaraja Rao, Madras.

The suitability of a fish for culture largely depends on its food and feeding habits. During an investigation aimed at ascertaining the relative importance for cultural purposes, of the different species of freshwater fishes of Madras, the food and feeding habits of the majority of them were elucidated. Data on the systematic analysis of the gut contents of *Cirrhina cirrhosa*, *Mystus seenghala*, *Pangasius pangasius*, *Silonia silondia*. *Megalops cyprinoides*, *Elops indicus*, *Notopteras notopterus*, *Anabas testudineus* and *Ophicephalus punctatus* are furnished in the present paper.

The strictly freshwater specimens of P.*pangasius* feed largely on gastropods and insects. *S. silondia* shows marked piscivorous tendencies. *M.Seenghala* takes in quantities of gastropods but is decidedly piscivorous also. Fingerlings of *M. cyprinoides* and *E.indicus*, naturally acclimatised to freshwater, feed largely on mysids and other crustacea, but have no predilection for cyclops. Insects and ostracods predominate in the gut contents of the climbing perch. Quantities of vegetable matter are also generally taken in. *N.notopterus* and *O.punctatus* are predominently insectivorous, and hence not destructive to other fisheries in any large measure. Plankton feeding and nibbling at algal growth are indicated in *C. cirrhosa*, the most important carp of the Cauvery.

31. On the Bionomics, Feeding Habits and Breeding of 'Karambai' *Barbus* (Lissochilus) *hexagonolepis* MacClelland in the River Cauvery, Madras.

K. H. Alikunhi, Madras.

Barbus (*Lissochilus*) *hexagonolepis* abounds in the Assam-Himalayan rivers. So far, it is not known to occur in peninsular India. Specimens of this mahseer, locally called 'KARAMBI', are however, common in the river Cauvery. The South Indian Specimens are of a bluish colour and in the general build of the body, very much resemble the 'Olive Mahseer' of the Pegu district. Specimens over two feet in length and 10 pounds in weight are not uncommon in the Mettur—Bhavani stretch of the Cauvery.

Karambai is a voracious feeder. Length of gut varies from 2·5 to 5 times the total length. Intestine is usually gorged with marginal grass, aquatic weeds, gastropod shells and insect parts.

Breeding in the Cauvery corresponds with the monsoon months, and 1-2″ long fingerlings are available in large numbers during Febuary-March and June-July. Natural seed nurseries are being exploited for stocking lentic waters. Growth in the latter is, however, slow.

32. Fisheries of the Manjra River

M. Rahimullah, Hyderabad-Deccan.

Observations on the breeding habits of the carps and cat-fishes are in progress and it has been found that during the rainy season, i.e., June to August, the ratio of the catch of carps to cat-fishes was 85 :15 in 1946 but in 1947 it was 93 :7. The cat-fishes are plentiful in the deep pools during other seasons but the carps are very few.

It is due to the difference in the breeding habits of these two types of fishes because the cat-fishes breed even in impounded water and in tanks but the carps breed only during the rainy season when the rivers are in spate.

A peculiarity about *Catla* is that it is not found in the river at other seasons than the rains and takes shelter in the reservoir. It has not been reported above the Ghanpoor Anicut nor down Nizam-sagar reservoir in the stream although it is caught in fairly large numbers in the Godavari river of which the Manjra is a tributary.

Further investigations down the reservoir are under progress to find out the factors governing the breeding habits of *Catla*.

33. Life History of the Scale Carp *Cyprinus carpio* var *communis*, (Linn.).

A. R. K. ZOBAIRI *and* N.V.CHOODAMANI, Ootacamund.

The Scale carp, *cyprinus carpio* var *communis*. is one of the three varieties of the German Carp popularly known as the *MIRROR CARP*, introduced in the Nilgiris in the year 1939 from Nuwara Eliya, Ceylon; the three varieties differing among themselves only in the matter of their scaling. The life history of this carp was studied by stripping and artifically fecundating its ova and correlating the various stages in development with those of the contemporary eggs obtained from the Wilson Fish Farm and the lake at Ootacamund, Nilgiris.

Breeding Season : The Scale Carp, as also the other two of its varieties are found to breed all the year round in the Nilgiris except during the South West Monsoon months JUNE-SEPTEMBER ; JANUARY-APRIL being the peak period of breeding.

Breeding Habits : Distinct spawning groups are met with consisting of one large spawner and three to five small milters. The spawn is shed by violent muscular contractions of the body and fertilised in water. Eggs are demersal and adhesive settling on aquatic weeds. The Scale Carp has an incredible fecundity.

Fertilised Egg : Spherical with a glassy vacuolated yolk and dilated with a distinct perivitelline space. It has an average diameter of 1·3 mm.

Development : Dilation of the egg begins three minutes after and is completed about ten minutes after fertilisation. Formative protoplasm appears one hour after fertilisation. First cleavage starts sixty-two minutes after fertilisation. Segmentation is meroblastic and unequal. The blastoderm invades the yolk upto its equator and the embryonic ridge is differentiated eight hours ; blastoderm envelops the yolk completely leaving a blastopore and an embryo with 12 somites is differentiated eight and half hours, a well defined embryo with 33 somites develops sixty-nine hours, after fertilisation. First hatching takes place seventy-two and a half hours after fertilisation and continues upto seventy three hours in water varying in temperature between 20°C-23·5° C.

The newly hatched larva averages 2·5 m.m in length with no mouth, alimentary canal, anus or gills. Notochord is cellular. Heart is seen pumping colourless blood about 82 times per minute. Mouth and anus open and the larva beigns to feed and respire on the third day after hatching. It is carnivorous to start with feeding voraciously on *Daphnia* sp.

Scales make their first appearance on the forty fourth day after hatching. The larva completes its postembryonic metamorphosis and becomes a replica of its parents fifty-first day after hatching when it measures 3.5 cm. and 0.8 cm. in length and height respectively.

34. Food, Feeding Habits and rate of Growth of the Mirror Carp, *Cyprinus carpio* (Linn.).

A. R. K. ZOBAIRI *and* N. V. CHOODAMANI, Ootacamund.

Many fantastic stories relating to the gustatory propensities of the Mirror Carp are current, particularly in the West, which have rendered the usefulness or abnoxiousness of this carp a controversial matter. Since its introduction in the Nilgiris (1939) the Mirror Carp is found to be the best food fish, ideally suited for culture in the fallow highland waters. A comprehensive knowledge of its bionomics is therefore essential. While giving an account of the food, feeding habits and the rate of growth of this fish in this paper an attempet has been made to examine the various charges levelled against it.

The mouth of the Mirror Carp is devoid of teeth and is essentially suctorial. A complex armature of pharyngeal teeth exists in its throat. The adult mirror Carp is an omnivorous creature with predilections more towards vegetarianism. It is a typical plankton feeder in addition, and is neither carnivorous nor predaceous.

The Mirror Carp larva commences alimentation when it is about 7.0m.m. long and is carnivorous upto 4·7 c.m. At 5·5 cm. it begins to take diatoms and desmids in addition. The proportion of animal and vegetable matter at this stage is almost fifty fifty. The vegetable matter increases in proportion at 6·3 cm and beyond.

The roiliness of water caused by the Mirror Carp by its thrashing about at the bottom is not found to be injurious to either fish or to the growth of plankton. The aquatic vegetation is not destroyed in its entirety by this Carp.

The rate of growth of the Mirror Carp is directly proportional to the quantity of food available. It grows at the rate of 2·5 cm to 4·2 cm per month in the Wilson Fish Farm and the lake at Ootacamund, where the natural food of the carp is abundant. It is a very hardy fish, capable of enduring every adverse condition admirably. It lives for several hours out of water and is alive and active even after severe mutilations.

35. Preliminary Investigations on the Food of Trout in the Nilgiri Streams.

N. V. Choodamani, G. Lakshminarayana Rao, V. Ranganathan, *and* A. R. K. Zobairi, Ootacamund,

The Trout introduced successfully in the Nilgiris in the year 1907 is an acclaimed favourite amongst the anglers as elsewhere, but the successive deterioration in its size has been the chief concern of its well wishers. Investigations into the causes of this are systematically being carried out and the present article deals with the results of work done in this direction, which is of a preliminary nature.

The knowledge of the kind and amount of food in each river and lake available for the Trout as well as of the quality and relative quantity of the items of its menu is important for any intelligent management and improvement of Trout fisheries. This could be acquired by a comprehensive analysis of the stomach contents of Trout corr-ellated with an exhaustive biological survey of the waters. The paper deals with the results of the preliminary investigations of such a type of work on the Trout in the Nil-giris and its hill streams.

The eight waters out of about sixteen rivers, streams and lakes now populated by Trout on the Nilgiris selected for investigation are listed. The data on the quantitative analysis of over 120 samples of gut contents are tabulated. The different items of the food come across in the contents of the stomach are arranged in the order of their relative abundance. It is seen that insects constitute the bulk of the Trouts' dietary. Hence the biological survey of the waters were made with special reference to the riparian and aquatic insects and their under-water stages. The differnt species of the various orders of Insects met with in the streams have been identified as far as possible and described. 4 genera of Caddis flies (Trichoptera), 2 of May flies (*Ephemeroptera*), a solitary genus of Stone flies (*Plecoptera*), 4 aquatic and 3 terrestrial genera of Beetles (*Cole-optera*), 2 of water bugs (*Hemiptera*), 2 of True flies (*Diptera*), have been represented in the streams, either by their larval and nymphal stages or adult forms. Larval forms of the genus *Chironomus* (the midges) and *Eriocera* (Crane fly) have also been noted. The Black ant' of the fly-fisherman is a non-aquatic *Hymenoptera* belonging to the family *Formicidae* haunting marginal trees, wherefrom they are dislodged by wind into the streams. *Crustacea* are represented by Carbs, the fairy shrimps, and the non-indigenous shrimp, *Cardina* sp. Molluscs are represented only by a thick-shelled Gastropod *Neritina* sp., and a species of limpets belonging to the genus *Paludonius*. Earthworms have been noticed to form the exclusive food of Trout on certain occasions during the monsoon. The Minnows, *Danio* sp. form the undesirable aliens into Trout waters.

From the above study it is concluded that the Nilgiri Trout is entirely carnivorous. The sufficiency of the food available in the streams is discussed. It is found that the Trout are not underfed. The comparative seasonal abundance of surface and submerged fauna and the influence of floods on the same are also discussed. Conclusive observations in this respect are much desired for prescribing angling seasons with a view to improve the quality of the fishing.

36. On the nutrition of the young stage of Certain Freshwater Fishes of Madras.

P. I. Chacko *and* S. V. Job, Madras.

The food of the fry of 17 species of fresh water fishes of Madras were investigated, with the following salient features. (1) *Barbus tor*: Algal filaments, *Pleurosigma*. *Pinnularia*, *Coscinodiscus* and particles. (2) *B. carnaticus*: insect remains, algal mater and sand grains. (3) *B. hexagonolepis*: algal matter, *Pinnularis*, *Pleurosigma* *Fragillaria* and *Gomphonema*. (4) *B. curcuma*: insect remains. (5) *Cirrhina reba*: *Oscillatoria*, *Lyngbia*, *Rhizoclonium*, insect life, daphnids, *Navicula*, *Pinnularia* and *Tabellaria*. (6) *C.cirrhosa*: algal matter, *Mastogloia*, *Eunotia* and sand grains. (7) *C.fulungee*: *Hydrilla*, *Closterium* and *Pleurosigma*. (8) *Labeo fimbriatus*: *Closterium*, *Coscindiscus*, *Cyclotella*, *Fragillaria*, *Navicula*, insect remains, copepods, daphnids and sand particles. (9) *L.calbasu*: *Anomoeneis*, *Mastogloia*, *Spirogyra*, copepods and rotifers. (10) *Silundia sykesii*: water beetles and sand. (11) *Callichrous bimaculatus*: fish remains, insect remains and sand. (12) *Macrones gulio*: fish remains, insect remains, fish eggs, *Closterium*, *Fragillaria* and sand. (13) *M.cavasius*: insect remains and fish scales. (14) *M.seenghala*: *Spirogyra*, *Oscillatoria*, *Navicula* and *Pinnularia*. (15) *Bagarius bagarius*: young prawns, fish remains and sand. (16) *Glytothorax lonah*: insect remains, algal matter and sand particles. (17) *Wallagonia attu*: fish larvae, *Closterium*, *Fragillaria* and algal filaments. The young stages of these species, are owing to their habit of feeding on insect life, useful as mosquito-larvae destroyers.

37. A Case of 'Gas Disease' in *Catla catla* (Hamilton).

P. I. Chacko *and* S. V. Job, Madras.

The cause for a case of heavy mortality that occurred in July 1947, among the population of *Catla*, 10-12 inches in size, in a Municipal pond in Madura, was diagnosed as Gas Disease by the following symtoms: (1) ragged and tattered appearance, (2) scales fallen off in round patches at the base of the dorasal, pectoral and ventral fins, (3) skin pealing off on touch, (4) loss of blood through the skin, (5) presence of gas bubbles in gill filaments, heart and blood vessels, (6) presence of as bubbles in the gut which contained the normal items of food of the fish, and (7) air bladder highly distended and filling the visceral cavity by bursting through the peritoneum. Bacteria were not concerned with this disease. The immediate cause of death was asphyxiation from gas, embolism in the gill filaments and heart. Aeration of the pond water by dragging a net across for over two hours gave satisfactory results, and about 25% of the fishery was saved.

38. A Preliminary Note on the Hilsa Fishery Investigations in South India.

P. I. Chacko *and* B. Krishnamurthi, Madras.

In South India, *Hilsa ilisha* (Hamilton) occurs in the coastal waters from Vizagapatam to the Palk Bay. The fish is rare in the Gulf of Manar and the West Coast. During the flood season it shoals into the rivers up to the first anicuts. This shoaling is more in the early hours (2-6 A.M.) of the days during the New Moon period. The spawners do not feed. The males reach the spawning grounds earlier. The left testis is larger. The fertilised egg is drifted into the tidal area, where development and hatching occurs. The fry move about in association with those of *Chatoessus chacunda* (Hamilton). The fish spends the first two years of its life in the tidal zone, feeding on planktonic organisms. It then moves into the 3-8 fathoms limits of the coastal sea. The Hilsa fisheries have recently declined owing to the construction of dams and anicuts and the consequent moderation of floods. There is also destructive fishing of spawners and young ones. A detailed investigation is being conducted.

39. Development of Fisheries of the Periyar Lake.

P. I. Chacko, Madras.

The Periyar Lake is 10·20 sq. miles in area, and is situated at an elevation of 2800 feet, surrounded by thick forests. As a programme for the development of its fishery, a survey of the indigenous fish fauna was made, and 29 species were listed. To improve the quality of the fishery, a consignment of the quick-growing carp, *Catla catla* (Hamilton) was brought from the Godavari and introduced into the lake for the first

time in October 1946. A consignment of the Milkfish, *Chanos chanos* (Forskal) collected from the sea (salinity 17.49%) around Krusadai Island was also stocked in the lake in April 1947. The thriving and growth of these semi-exotic species in the lake are being watched with interest.

40. On a Fish Survey of the Cauvery, Madras.

P. I. CHACKO *and* G. K. KURIYAN, Madras.

The fluviale fishery of the entire Cauvery system within the Madras Presidency is under the control of the Fisheries Department. This river yields about 65% of the inland fishery revenue. During a survey of the river, 77 species have been listed. Species which form a special feature of the fish fauna are *Barbus hexagonolepis*, McClell, *B. carnaticus* (Jerdon), *B. tor* (Hamilton), *Labeo ariza* (Hamilton), *L. boga*(Hamilton). *L. kontius* (Jerdon), *L. nigrescens* Day, *Cirrhina cirrhosa* (Bloch), *Osteochilus* (*Kantaka*) *brevidorsalis* Day and *O. nashi* Day. In pursuance of a programme of fishery development, the river was stocked with the upper Indian carp, *Catla catla* (Hamilton) from 1923 onwards,. This fish has established itself and now forms a large portion of the river fishery. Other species introduced into the river are *Osphromenus gourami*, Lacep. *Etroplus suratensis* (Bloch), *Labeo rohita* (Hamilton), *Cir rhina mrigala* (Hamilton) and *Chanos chanos* (Forskal). The first two species have bred and spread themselves in the river system. Location and exploitation of spawning and nursery areas is a regular annual feature. Destructive methods of fishing are prohibited ; and congregation areas of migratory species below dams and anicuts are delcared as sanctuaries.

41. On the Bionomics of the Larvivorous Fishes of Madras.

P. I. CHACKO *and* R. S. VENKATRAMAN. Madras.

The local distribution and densities, food and feeding habits, breeding grounds, seasons and habits, communal associations and larvivorous propensities of the following larvicidal fishes of Madras are detailed : *Aplocheilus lineatus*, *A. blochii*, *Amblypharyngodon mola*, *Ambassia* nama,*A. ranga*. *Barbus ticto*, *B. sophore*, *Barilius bendelisis*, *Chela argentea*, *Colisa fasciatus*, *Danio aequipinnatus*, *Esomus danrica*, *Etroplus maculatus*, *Gambusia affinis*, *Lebistes reticulatus*, *Macropodus cupanus*, *Oryzias melastigma*, *Perilampus atpar*, *Rasbora daniconius* and *Therapon jarbua*.

42. On the Histrory and Transport of the Mirror Carp in Oxygen Container from Ootacamund (Nilgiris) to Kumaun Hills (United Provinces).

B. SUNDARA RAJ *and* R. P. CORNELIUS, Lucknow.

The mirror carp a native of China and extensively cultivated for centuries in Europe was introduced from Germany into the Ceylon waters in 1914 and thence into the waters of the Nilgiris in 1939 by the senior author. On the Nilgiris they have flourished and are now providing a valuable new fishery.

For the improvement of Kumaun water an attempt has been made to introduce this fish. A special oxygen carrier was designed by the senior author for the transport of fingerlings from Ootacamund to Kumaun hills by aeroplane. The carrier and its use are described. After testing the apparatus the junior author brought 60 fingerlings of mirror carp partly by train and partly by air (Madras to Delhi) withough a sinlge casualty which proves the efficiency of the carrier. This is the first time that the mirror carp has been introduced anywhere on the Himalayas. The fish are growing well in a reconditioned pond in the Bhowali trout hatchery. The aim of the paper is to record the introduction of this new fish to Himalayan waters and to bring to the notice of the persons interested this simple and handy carrier.

43. On he Bionomics, Development and the early Growth Rate of the Cauvery Carp, *Labeo Kontius* Day.

K. H. ALIKUNHI *and* S. NAGARAJA RAO, Madras.

One of the major carps, growing to about a foot and a half, *Labeo Kontius* is indienou s to the Cauvery system.

Systematic analysis of stomach contents revealed that diatoms and algal filaments predominated in the menu. Bits of leaves, insect and worm remains, copepods and rotifers were also taken in.

With the onset of the south west monsoon in June, specimens 12 to 14 inches long become sexually ripe. Developing eggs, drifting along, were collected from the Cauvery at Hogainakal in July, '46. Water was muddy; temperature 23·5°C. to 23·6°C; pH. 7·5 to 7·8; percentage of saturation of dissolved oxygen, 84·5 to 98·4 and free carbon dioxide, 0·091 to 0·122 parts per 100·000.

Spawning takes place in the early morning hours. Fertilised egg is 3·5 to 4m.m. in diameter, demersal and transparent. Yolk is finely granular and of a sky blue tinge. The period of incubation is about 27 to 30 hours. The hatchling, about 3 m.m. long is transparent. On the 4th day after hatching the larva begins feeding.

By rearing the larvae a complete series of postlarval stages has been obtained. Growth of fingerlings under natural and artificial conditions has been followed, the data gathered affording interesting comparison.

44. Observations on the growth of *Cyprinus Carpio* in Tropical Environment at the Chetput Fish Farm, Madras.

K. H. ALIKUNHI *and* S. NAGARAJA RAO, Madras.

The successful acclimatisation of advanced fingerlings of *Cyprinus carpio* to the tropical conditions at Madras has been reported by Alikunhi & Runganathan (1946). Subsequent experiments of transportation have fully demonstrated the hardiness and the easy adaptability of the species, even in the early fry stage, to sudden climatic changes.

Fed on live plankton and soaked oil cake, the fry thrived well in nursery tanks. Early growth rate of all the three varieties of *C. Carpio*, viz; *communis*, *specularis* and *nudus*, have been followed regularly, first at weekly, and later on, at fortnightly intervals, at the Chetput Fish Farm, Madras. Growth is more or less uniform in the three varieties. From the half inch fry stage the average fingerling size of 4 inches was attained in the course of 3 months in cement nurseries. Growth in natural ponds is much quicker.

45. Food, Feeding Habits and Growth of Fingerlings of the Fresh-water Shark *Wallagonia attu* (Bl. Schn.).

K. H. ALIKUNHI, Madras.

Analysis of the stomach contents of specimens from the Cauvery, Godavari, Kristna and Tungabhadra confirm the marked piscivorous tendencies already noted by earlier workers.

Pronounced cannibalistic leanings were observed in fingerlings kept in nursery tanks containing abundant forage fish.

Peculiar feeding habits like 'lying in wait' for the approaching prey and darting at it with unerring precision and lightning rapidity resulting in the shooting out into the air of the aggressor himself are described.

Provided with sufficient forage fish, quick growth averaging about 3·3 inches per month is recorded in fingerlings kept in small nursery tanks.

46. Influence of Temperature on the Rate of Embryonic Differentiation in *Rasbora daniconius.*

K. H. ALIKUNHI *and* G. LAKSHMINARAYANA RAO, Madras.

Intensive breeding of *Rasbora daniconius* was observed during November, soon after heavy monsoon rains, in Madras. In the Ootacamund lake ripe oozing specimens of the same species were plentiful during March and September.

Embryonic and larval development was followed at Madras from naturally fertilized eggs collected from farm ponds, while, at Ootacamund oozing specimens of either sex, caught from the Ootacamun lake, were stripped and the ova artificially impregnated.

The average temperature of water in Madras during November was 27·06°C at 9 A.M. and 28·44°C at 4 pm. The period of incubation lasted for about 86 hours and the larvae hatched out on the fourth day after fertilization. The embryonic differentiation was studied in detail.

The average temperature of water in the Ootacamund lake during September was 17.2°C. The period of incubation was very much prolonged and hatching took place on the 12th day, 267 hours after festilieation.

With a difference in temperature of about 11·2°C the rate of embryonic differentia tion in Madras is thrice as quick as in Ootacamund.

The adaptability of the species to different thermal conditions is interesting.

47. Growth, Maturity, and Brood care in the Murrels *Ophicephalus striatus* and *O. pnnctatus.*

K. H. Alikunhi, Madras.

Murrel forms the bulk and mainstay of the tank fisheries in several districts in Madras and is generally considered excellent for eating.

Recent investigations of Mukherjee, Rahimullah and others have supplemented the pioneer observation on the bionomics snd breeding of murrels made by Willey and Raj. Specific data on the growth, fattening and age at maturity of this important group are of practical significance in culture.

Embryonic and larval development of *O. striatus* were studied in the laboratory. Post-larval growth and fattening were followed in the natural pond by segregated rearing. Yearlings, 8—9 months old were found to have the gonads in the fourth stage indicating that they would be ready to breed during the coming north-east monsoon.

Analysis of the natural food of fry and fingerlings have been made ; the variation in growth in response to the relative abundance of food are noted.

Disparity in size between sexes was always noted. Additional data on brood care are furnished.

48. Note on the Spawning of Carps in the River Thungabhadra in Response to 'off Season' Freshets.

S. V. Ganapati *and* K. H. Alikunhi, Madras.

An instance of carp spawning observed in the river Thungabhadra at Sunkesula on 24-9-46 is discussed.

Water level in the river was low. There were heavy rains in the evening on 23-9-46, six to seven miles above Sunkesula. The following morning water had risen in level and was turbid and muddy. Spawn nets fixed in the river by 9 a.m. near the Sunkesula fish Farm procured a small quantity of spawn and numerous hatchlings. The hydrological conditions before and after the rains were as follows :—

	Before Rains. (Pre-spawning)	After Rains. (Post-spawning).
Temperature.	28·2 to 28·5°C.	28·5°C.
Colour.	Pale brown	Brown-muddy.
Turbidity	30·0 cms.	2·7 cms.
Free CO2	Nil	0·202
CO3	0·3	Nil
HCO3	17·995	17·385
pH.	8·5	8·1
D.O.--cc/L.	4·746	5·14
Chloride (parts per 100,000)	1·3	1·7
P205-P.	Nil	Present.
NO3-N.	Nil	Present.

Carp and catfish eggs were present. On rearing in the labosatory the carp eggs were found to be those of *Cirrhina reba.*

Except for turbidity the hydrological factors do not greatly differ in the pre-and post-spawning periods. The rise in level probable afforded some suitable shallow spawning grounds for the late breeders.

49. On an Interesting Case of Carp Spawning in the River Cauvery at Bhavani in June, 1947.

S. V. GANAPATI, K. H. ALIKUNHI *and* FRANCESCA THIVY, Madras.

The spawning of the major Indian carps is generally associated with intensive flooding by turbid water. However carp spawn in thousands, was collected from the Cauvery at Bhavani on 29-6-1947 when the water was perfectly clear. There had been neither rain nor flood during the previous week in the locality and in the upper reaches.

The hydro-biological conditions were as follows:

Date.	Place.	Time.	Depth	Colour.	Temp. (°C.)	Flow. (miles per hour.)	pH.	Free C02	D.O. C.C. /L.	Chloride part per 100,000
29/-6/ 1947.	Cauvery at Bhavani.	12 p.m. to 8 A.M.	5 ft.	Bluish-green.	28·2 to 28·8	5·0	8·5	Nil.	4·74	1·7

Spawning commenced by midnight when the temperature was at its lowest and homothermal conditions prevailed. The percentage of saturation of dissolved oxygen was only 83 to 88.

A larger volume of water was being released from the Mettur reservoir for irrigation purposes, and some shallow stretches of the river-bed got submerged, which, it is presumed might have functioned as the spawning grounds.

The spawn collected was reared in the laboratory. It is found to contain 15% *Labeo fimbriatus*, 60% *Cirrhina reba* and 25% *Discognathus* sp.

50. On an Interesting Case of Mortality of Larvicides in the Public Health Fish Nurseries at Ennur, Madras.

S. V. GANAPATI *and* K. H. ALIKUNHI, Madras.

A set of six nursery ponds - one bigh and five small ones—is being maintained at Ennur for stocking and rearing larvicides, particularly *Gambusia affinis*. Though lying adjacent to one another, two entirely different sets of conditions are found to prevail in them. While in the large pond the fish thrives and breed quite normally, in the adjoining nurseries, separated from the former only by a narrow earthen bund, all the fish die within a few hours after stocking. Samples of water were analysed from all the ponds and the following data gathered:

	Large Pond.	Small Nursery ponds
Date	30-9-46.	30-9-46.
Time	10·45 A. M.	10·45 A. M.
Colour	Pale Brown	Nil.
Temperature (oC)	33·7	32·3 to 33·1
Turbidity	30·0 cms.	30·0cms.
Area	150' x 120'	15' x 10'-25' x 15'
Depth	4	2' — 3'
Free C02	Nil.	4·386 ft.— 8·460
C03 (parts per100,000)	1.65	Nil
HC03 parts per 100,000)	11.900	Nill
pH.	8.8	6.0
Dissolved 0·2 (CC /L)	6.324	4.319-4.624
Chloride parts per 100,000)	12.0	16.0-26.1
Macro vegetation	*Hydrilla, Ceratophyllum.*	*Hydrilla, lotus,* marginal grass.
Fish	*Gambusia affinis*	Nil

Plankton was nil in the smaller nurseries. Macro-vegetation was luxuriant in the pond as well as in the nurseries.

The excess of free carbon-di-oxide, absence of carbonates and bicarbonates and the consequent low pH (less than 6.0) appear to be the chief factors causing persistent mortality in the nurseries. The influence of natural bottom spring is probably responsible for the accumulation of free carbon-dioxide, covering the bottom withn layer of coral calcite, chalk or broken shells and the introduction of *Chara* have bees suggested to neutralise the effect of carbonic acid.

51. On the Bionomics of *Catla Catla* (C. *and* V.) in South Indian Waters.

P. I. CHACKO *and* G. K. KURIYAN, Madras.

Through systematic stokcing operation since 1922, the Madras Fisheries Department has succeeded to acclimatise and establish Catla as a major fishery in inland waters of South India. In its new environment, the food of the fish is found to consist of diatoms (*Coscinodiscus, Cosmarium, Cyclotella, Eraemosphaera, Faragillaria, Navicula, Pinnularia and Melosira*)—25%, crustaceans such as copepods and shrimps-25%, algal matter (*Volox, Hydrilla* and *Chara*)-30%, Protozoons (*Difflugia* and *Vorticella*) -5%, Polyzoons -1%, sand particles-4% and other unidentifiable items-10%. The fish attains mautrity when 22 inches in size, and broods in the river systems from July to November. The ovarian and fertilised eggs are 1.03and 4.38mm in diameter. Period of incubation is 18 hours. The hatchling is about 5mm in size, and it becomes a fry within 4 days and is characterised by large red tinged operculums. It has attained 29 inches and 9 lbs in the first year, and 3 to 4 feet and 40-50lbs, in three years. The rate of survival is 90%.

52. Hydrobiological Investigations of the Godavari River with reference to the Indian Shad, *Hilsa ilisha* (Hamilton).

P. I. CHACKO, S. V. GANAPATI *and* A. R. K. ZOBAIRI, Madras.

The Hilsa enters the Godavari upto the Anicuts, about 60 miles form the sea, during July -October for spawning. The methods of fishing employed are destructive. The hydrological conditions are—turbidity : 5.5-30.0 cm., temperature : 26.4-31.8°C, Free CO_2 :0-0.666, CO_3 : 0-0.9, pH :7.9-8.3, dissolved oxygen : 1.130-5.606 cc/l, chloride 0.5-205.0, phosphates and nitrates :nil. Current is greatest at the surface, being 1500 cusecs. Plankton in the river consists of *Navicula, Stauroneis, Aulacodiscus, Coscinodiscus, Oscillatoria*, copepods, daphnids, crustacean larvae and aquatic insects. Females predominate the Hilsa shoals. Sexual maturity is attained when 14 inches by the females, and 11·5 inches by the male. The fish abstain from feeding during the season. The amount of fat in a spawner is half a pound. About 13 lakhs of ova are present in one individual. The ovarian and fertilised eggs are 0·72 mm in diameter. Artificial fertilisation is easily accomplished.

53. Fish Production in Religious Institutional Waters.

P. I. CHACKO, Madras.

Religious institutional waters serve as fish sanctuaries, breeding and distribution grounds, and as fish production centres in Madras. The ecological conditions in these waters are favourable to fish life. The macrovegetation usually occurring in them are *Naymphaea lotus, N. rubra, N. stellata, Nelumbium speciosum, Jussiaea repens Ipomea aquatica, Ceratophyllum demersum, Hydrilla verticillata, Vallisneria spiralis, Ottelia alismoides, Eichornia speciosa, Typha elephantina, Pistia stratiotes, Lemna polyrrhiza* and *Potomogeton pectinlatus*. Plankton is represented by *Amphora, Anabaena Aphanocapsa, Caridina, Chaetoceros, Closterium, Copepods, Coscinodiscus, Cosmarium*, culex larvae, *Cyclops, Daphnids*, Ephemerid larvae, *Eudorina, Euglena*, fish eggs and larvae, *Gloecapsa, Halosphaera, Helioza, Lyngbia, Mastogloia, Melosira, Micronecta, Microcystis*, Nauplius larvae, *Oedogonium Oscillatoria, Pediastrum, Pleurosigma, Spirogyra, Spirullina, Staurastrum, Suirerella, Synedra*, rotifers and veliger larvae. The growth of fish in the first year is : *Catla* : 27" & 7 lbs, *Gourami* : 10" & 1¼ lbs, *Chanos* ; 25" & 2 lbs, *Etro-plus suratensis* : 9" & ½ m, and *Barbus hexagonolepis* : 7" & ½ lb. Catla has attained 3 feet and 35 lbs in there years in the Madura teppakkulam. A crop of 500 lbs, of fish was harvested in 10 months from the Puraswalkam temple tank, about 35 cents in area. Gourami and Etroplus freely breed in these waters, and thus become seed sources. Fish rearing also reduces mosquito larval incidence and thick water blooms . For the latter, *Rasbora daniconius* is best suited.

54. Growth-rate of Twenty-one Species of Fishes of Madras.

P. I. CHACKO, Madras.

The following is the maximum growth in the first year of life of 21 species of fishes reared in departmental and private farms in Madras. *Wallagonia attu*—30", 10 lbs : *Labeo fimbriatus* 15", 2 lbs ; *L. calbasu* 14", 1½ lbs ; *L. rohita* 26", 6½ lbs ; *L. kontius* —9", ¾ lb ; *Os chilus thomassi* 12", ¾ lb ; *Cirrhina cirrhosa*—10", 1 lb ; *C. reba*—8" ¼ lb ; *C. fulun* —6", ¼ lb ; *Catla catla*—27", 9 lbs ; *Thynnichthys sandkhol*—9", ¼ lb ; *Barbus heragonolepis*—6", ¼ lb ; *Megalops cyprinoides*—14", 1½ lbs ; *Chanos chanos*—18", 1¼ lbs ; *Notopterus notopterus*—12", 1 lb : *Lates calcarifer* 18", 3½ lbs ; *Ophicephalus marulius*—30", 4 lbs ; *O. striatus* 12", 1½ lbs ; *Osphronemus gorami*—9", 1¼ lb. *Etroplus suratensis* 11", ½ lb and *Cyprinus carpio* var *specularis*— 16", 3½ lbs. These data enable fish farmers to foretell and control their fish crops.

55. On the Significance of the Accessory Rings on the Scales of *Hilsa ilisha* (Hamilton).

P. I. CHACKO *and* A. R. K. ZOBAIRI, Madras.

Investigations conducted by the authors have revealed that the accessory rings present on the rings of *Hilsa ilisha* indicate the age and growth -rate of the fish. Scales from 170 specimens of both sexes, varying from 10·2 to 20·8 inches in body length, collected from the Godavari delta, were examined. The number of rings was found to represent the body length of the fish in inches, and also the probable age of the fish in months. Thus the specimen of 10·2 inches in body length had 10 accessory rings on its scale ; and the specimen 20·8 inches in body length 21 accessory rings. Further investigations are being pursued to ascertain if the fish contiues to grow in size and to add to the number of accessory rings until its natural death.

56. On the Productivity of a Fish Pond in Vizagapatam.

P. I. CHACKO, Madras.

The Dykes Pond in Vizagapatam town is used for fish rearing by the department of fisheries. It is 2 acres in area with a maximum depth of 12 and 3 feet respectively. After necessary preparations, it was stocked with 250 fingerlings of *Labeo rohita*, 3083 of *L. fimbriatus* and 1013 of *Catla catla*, from August to October 1945. A fish-crop of 2210 lbs. comprising of 50 *L. rohita* (12-18" & 1½-2½ lbs), 443 *Catla* (10-18" & 1-3 lbs) and 1500 *L.* fimbriatus (10-13" & ¾-1½ lbs) was harvested in March 1946. The receipt and expenditure were Rs 853 and Rs 323 respectively. The pond was again stocked with 5750 fingerlings of *Catla*, 1694 of *Labeo calbasu* and 120 0f *Cirrhina reba* in August and September 1946. In March and April 1947, another crop of 2315 lbs comprising of 180 *L. rohita* (12-28" & 1-6 lbs), 1026 *L. calbasu* (10-13" & ¼-1½ lbs), 422 *L. fimbriatus* (11-15" & ¼-1½ lbs) and 3900 *Catla* (10-16" & ½-2½ lbs) was harvested. The receipt and expenditure were Rs 600 and Rs 88 respectively. The average production of 1130 lbs of fish per acre, per year and the rate of growth of the species are satisfactory.

57. Notes on the Bionomics of the Millions, *Lebistes reticulatus* (Peters) in Madras Waters.

P. I. CHACKO. *and* R. S. VENKATRAMAN, Madras.

Lebistes reticulatus, considered not to be found in India since the failure of the stock introduced by Major Selby in 1909 to acclimatise in the country, was discovered in the sacred waters of the Rameswaram temple in February 1946. It was then transplanted into waters in the districts of Madras, Tanjore, Malabar, Salem, Cuddappah and Kurnool, where it has since bred and established itself. In the environments of Madras provincial waters, the species is found to be hardy and breeding throughout the year at intervals of three weeks, bringing forth 5-7 young ones, 10 mm in length, at each parturition. The size of the ovarian and fertilized eggs is 1·66 and 2·01 mm. The fish feeds on (*Navicula, Cosmarium, Synedra, Closterium, Pinnularia, Fragillaria, Melosira, Nitzschia* and *Surirella*)—30% ; insect life, including mosquito larvae—25% ; Crustaceans such as copepods, daphnids and cyprids—20% ; algal matter such as *Anabaena, Cladophora, Oscillatoria, Pediastrum* and *Spirogyra*—15% ; *Rotifers*—5% ; *Larval worms*—3% and miscellaneous staff—2%. It is a larvicide of moderate utility, its rate of larval consumption being 20-80 per day. It may , however, become in course of time, a useful addition to the indigenous larvivorous species,

58. Gobioid Fishes of Bombay.

D. V. BAL *and* C. B. GUPTA, Bombay.

This paper deals with the taxonomic notes and distribution of a number of Gobioid fishes along the shores of Bombay and its neighbourhood. Of the 38 species recorded here two are new to science and are described in detail. As regards the known species a number of variations in the range of fin formulae, the various proportions of the body and its general colouration were observed and are given as an additional information. The variations noted are strictly in accordance with those observed on comparing the local specimens with the description given by Koumans in this memoir on "Gobioid Fishes of India ".

59. Nucleolar activity in the Oocytes of some Marine Teleostean Fishes.

H. S. CHAUDHRY, Cuttack.

This paper deals with an interesting phenomonon of nucleolar extrusion in the cytoplasm of the eggs of some marine teleostean fishes. The nucleoli in the young oocytes are fairly big in size and are strongly basophil in nature. They pass out into the cytoplasm through the nuclear membrane as whole bodies. On reaching the cytoplasm they travel towards the egg periphery, where they ultimately disappear without taking any visible part in the process of vitellogenesis. It has been clearly observed that the extruded nucleoli are neither myth nor artifacts due to any mechanical injury.

60. Modification of the facial structures in the Major Carps of India in relation to their feeding habits.

H. K. MOOKERJEE *and* D. N. GANGULY, Calcutta.

In this paper attention is directed to study the correlation between the food, feeding habits and the changes in the facial parts during the developmental period in the four major carps, like *Catla catla, Cirrhina mrigala, Labeo rohita* and *Labeo calbasu.*

The above four major carps can be grouped into three associations according to their feeding habits :- (1) Fish which feed mainly by sight, (2) Fish which feed by sight aided by taste ,and (3) Fish which feed mainly by taste. These fish are bathymetrically distributed ;some of them feed at the surface of the water, others at the middle and the rests are obtained at the bottom. *Catla catla,* the example of the sight-feeding type, is a surface feeder ; *Cirrhina mrigala,* the example of both sight and taste-feeding type is a partly surface feeder and partly bottom feeder ; *Labeo rohita,* a member of the taste-feeding type is mid feeder, and *Labeo calbasu,* another member of the taste-feeding type is completely bottom feeder.

From the study of the modifications of the facial structures during the developmental history of the above type it is obvious that the sight feeders possess large eyes, big upturned mouth well adapted for perching, and the absence of sensory papillae and barbels in the above area. Whereas in the taste-feeding types opposite characters are found, and the intermediate form possesses the characteristics of the both in a more or less degree.

It is noticed that during the early parts of the developmental history all the types take in similar diet and all possess similar facial structures and habits. This condition s clearly visible in 10 to 12 mm. stages of all the types of carps. The gradual differentiation of the structures commences from the 14mm. stage and progresses very slowly upto 20-22 mm. stage as during these stages the diet and the mode of feeding practically remain unchanged. The differentiation is very rapid in the stages between 23-50mm. as during this period food and feeding habits also undergo changes in different types. By this time the bathymetric distribution of the feeding range is also established. The degree of differentiation becomes unchanged or very little changed from 50 mm stages upwards as during this period no further change in the habits or food is marked.

61. On the probable inter-relationship between the Major Carps of India.

H. K. MOOKERJEE *and* D. N. GANGULY, Calcutta.

All the four types of the major carps of India, viz, *Catla catla, Cirrhina mrigala Labeo rohita* and *Labeo calbasu* are identically same and possess similar feeding habits and bathymetric distribution during the early stages of their development, The sequence of development in all of them is also very similar.

The presence of the obvious correlation between the nature of food, feeding habits and the modifications of the mouth parts speculate that the variable distribution is the cause of the evolution of the modern Major Carps from *Calta catla* like ancestor, where barbels and sensory papillae were absent like the modern *Catla catla*, due to the fact that during early stages of the life history all of the fish show *C. catla* like form.

The fact that the barbels and sensory papillae are relatively late in developing in *Cirrhina* and *Labeo* and the absence of them in *Catla* argues in favour of their being recently developed characters. Would it not be the case, vestigeale of these structures should have persist in *Catla catla* as it is well kmown how tenaceously vestigial structures persist, even when they do not subserve any conceivable function, so long as their retention is harmless to the organism. In the case of the barbels and sensory papillae, their presence would not involve any serious tax on nutrition during the life time of the fish nor be detrimental in any other way, and under such circumstances, once they had been evolved for any special purpose, the tendency of heredity might be sufficient tq secure their retention even though their primitive physiological value had become lost.

From the sequence of development, following the recapitulation theory, we can justify that the extremely modified form like *Labeo calbasu* had developed from the less specialized form like *Catla catla* through the intermediate forms like *Cirrhina mrigala* and *Labeo rohita*.

62. Pyloric Ceaca in *Mugil troschelii* Bl.

M. Rahimullah, Hyderabad-Deccan.

The morphological details of the alimentary tract in general and the structure and disposition of the pyloric caeca in particular have been described. The caeca in this fish are numerous and are found clustered over the 'Crop' in the form of bunches, each bunch consists of three to four diverticula opening into a duct, those ducts in turn open into the pylorus.

The caeca of this fish have been discussed in relation to those of other members of the fam. Mugilidae, and it has been inferred that the disposition and the number o the caeca have practically no taxonomic importance in the systematic study of fisho even in a single family.

63. The structure, form and development of scales in *Mugil* sp.

S. Mookerjee, Calcutta.

This paper embodies details of the structure, form and development of scales of *M. sp.* A morphological survey reveals the characteristic feature of the scales. The location of focus, the nature of circuli and disposition of radii have been studied in these scales. The posterior fields of the scales are delineated with small elevations, placed one after another in a linear way.

Developmentally it has been found that these scales are like cycloid scales at theif earliest phase, later they assume the adult condition through successive phases or development.

The affinities of these scales with cycloid and ctenoid scales described previously have been indicated.

64. On the Development of the Vertebral Column in Crocodilia.

H. K. Mookerjee, *and* R. N. Bhattacharya, Calcutta.

The notochord of Crocodilia has two sheaths instead of one. Centrum is fromed by two concentric rings of *perichordal tube* instead of one and not by addition to or prolongation of the base of the upper (or in some cases by addition to the lower) arch as stated by previous investigators. The upper arch rests at the dorsal corners of the concentric rings of the *perichordal tube* and there is a suture in between, giving their distinct identity. The dorsal arch is formed not only by the *basidorsals* of either side but, there is a third piece of cartilage as *supra-dorsal* from which the neural spine is formed. Apart from cartilaginous *basidorsals* there are membranous anterior and posterior *connective tissue arches* which are also transformed to a cartilaginous condition at a much later stage,. These three elements are responsible for the formation of the *upper arch* which escaped the notice of previous workers in this line of enquiry. The *basiventral* element represents a flat piece of cartilage for the atlas vertebra. The rest

of the body-vertebrae have united *basiventralia* as *intercentra*. Caudal vertebrae have regular haemal arches with a third piece as *infraventrals*, the existence of which was not known.

Two types of ribs are present, one is the ventral rib articulating with the united *basiventralia* of atlas vertebra with one head (ventral), the rest are all of the dorsal type; a few have two heads and others have only the trabecular process articulating with diapophysis.

65. Observation on the Bursa of Fabricii in Domestic Fowl.

J. N. Rudra and S. Mookerjee, Calcutta.

Bursa of Fabricii of birds has a much debatable existence in the adults. Various workers have formed different opinion about the fate and function of this structure. In order to elucidate the fate and function of Bursa Fabricii, a large number of adult fowls were examined by us. Morphological and histological studies revealed the well developed condition of this structure and the presence of copious sperms inside the Bursa led us to assign the function of a spermatheca to this structure.

Detailed anatomical and physiological works are being carried on.

66. Reproduction and Early Pregnancy in the Vespertilionid Bat—*Scotophilus wroughtoni* (Thomas).

A. Gopalakrishna, Nagpur.

A general survey of the work done on the reproduction of Micro-chiroptera indicates that the sex rhythm of the bats of the cold climates is very different from the same in the bats of the tropical regions. In the European varieties usually copulation occurs during late autumn and the Spermatozoa are stored inside the genital tract of the female through winter and fertilization occurs in spring. These spermatozoa therefore, hibernate for nearly 5 months. (Harrison Matthews 1939). Several authors working on American bats have recorded that copulation occurs in spring, and is immediately followed by pregnancy. (Mary, J.Guthrie 1933). The only work on tropical bats (Baker and Bird 1937) shows that in New-Hebrides copulation occurs in spring only. Harrison Matthews has also recently shown (1942) that in most of the African bats, presumably there is nothing comparable to the winter hibernation of spermatozoa as occurs in European species.

The present study also proves that copulation occurs at the begining of spring and is followed by fertilization and pregnancy in *Scotophilus wroughtoni*. The males and the females come to sexual activity at the same time of the year, that is spring. There is an annual breeding season . The males and the females become fecund in their first year, that is before they are one year old a phenomenon which has not been recorded in any species of micro-chiroptera so far.

of searly stag pregnancy :—

The earliest stage obtained was morula. A slightly later stage with clefts between cells is also observed. The third stage was an un-implanted free blastocyst which has differentiated into an outer trophoblast and an inner cell mass which is attached to the trophoblast at one pole. Further stages are being studied.

67. Plant Protection Service.

K. B. Lal, Cawnpore.

Plant Protection Services, whether organised by the Central Government or in the provinces and states, being new ventures in India, raise certain improtant issue of principle, organisation and operation which call for discussion. The main functions of a Plant Protection Service must be to organise large-scale control measures against pest and plant diseases, to prevent their entry or spread in the provinces and states, to predict and issue warnings against them and to educate the farmer in the methods and need for their remedies against them.

Though goverments must always provide technical advice and assistance in fighting pests and diseases, in the initial stages of the Service the entire cost of all operations also must be borne by them. This latter concession is nescessary because the cultivator is not yet in a position to realise the benefits that may accrue to him from the adoption

of measures against pests diseases. After the stage of intensive persuation and propoganda has passed, some legislative measures may be necessary to compel such cultivators as do not adopt control measures against pests and diseases or allow others to do so, thereby injuring not only their own interests but also those of their neighbours. Legislation should also be necessary to regulate the sale and manufacture of insecticides and fungicides. The issue of forecasts of pest and disease ourbreaks organisations of quarantines against pests and diseases and propaganda must always be the responsibility of governments. The Central Government should undertake the training of staff needed for Plant Protection Services, arranging the courses of training in such a way as to allow ample scope for specialisation in different branches of plant protection work. Plant Protection Services must continually collect facts and data for assessing the efficacy of the measures adopted by them. The Service nust be under a unified control and be alive to need for collaboration with research workers on the one hand and with district agricultural staffs and indeed all those interested in village improvement, on the other.

SECTION OF BOTANY

PRESIDENT : K. AHMAD CHOWDHURY, M.B.E., D.Sc., F.N.I.

Cryptogams

1. A revision of the genus *Turbinaria* Lamx.

FRANCESCA THIVY, Madras.

Miss E. S. Barton's famous monograph of the genus was written in 1891 and since then important collections from all regions have accumulated and have necessitated a revision.

Barton recognized 9 species and 2 varieties. While the former are maintained, the latter are here raised to species and several new species are reported. Additional specific criteria have been established. The geographic distribution of the species is considered here to be discontinuous.

A synoptical key to the species, illustrated specific descriptions, references to literature and citations of herbarium specimens are provided.

2. *Asterionella Krusadiana* Sp. Nov. from the Gulf of Manar.

FRANCESCA THIVY, Madras.

The specimens were found free-floating in a sample of water from the channel between Krusadi I. and Pamban I. on the 28th February, 1947, along with *Enhalus* leaves with epiphytic *Spirorbis* shells.

Resemblance to *A. kariana* Grun., Cleve & Grun. in forming spiral colonies and to some extent in the shape of the frustules, to *A. notata* Grun. in the frustules in a chain diverging in all directions., and to both these species in the presence of a number of chromoplasts scattered throughout the frustule, is found in the specimens under discussion, but the broadly cuneate shape of their frustules, marks them as being distinct from either of the above species. The broader ends of the frustules are joined to form the chain and the tapering takes place towards the free, faintly rounded, narrower ends. A detailed illustrated account of the new species is given.

3. Algae of the ponds at the Govt. Fish Farm, Madras.

FRACESCA THIVY, Madras.

A systematic study of the algal blooms and littoral algae of the fish ponds was carried out during the year, August 1946-47. Over eighty genera are represented.

The phytoplankton is on the whole of the "Baltic" type as it shows predominance of Chlorococcales and Myxophyceae and paucity of desmids. In some ponds Euglenophyceae are often dominant, which is a pond as against a lake feature. The composition of the phytoplankton in the different ponds, which are under similar conditions, also contrasts with lakes in its diversity.

Illustrated descriptions of the species and ecological findings are given.

4. Some New Hosts of *Cephaleuros*.

K. M. Safeeulla and H. C. Govindu, Bangalore.

In the present investigation the authors have recorded a number of hosts of the alga *Cephaleuros*. The infection of this is very intense during the raniy season.

On *Psidium guajava* L. and *Olea dioica* Roxb., the alga is definitely parasitic in nature. In these cases a greater portion of the thallus of the alga is intramatrical, as a result of which, the cells of the leaf tissue of the host assume a polygonal aspect. Out of the twenty seven hosts collected, except the above two hosts, the rest show that the alga is essentially epiphytic. In a few cases, the alga, even as an epiphyte, causes damage to the host, by reducing the photosynthetic area by forming innumerable dense orange coloured patches.

5. Indian Sphagnums.

Arun Kumar Sarma, Calcutta.

Very little work has been done on Sphagnum mosses of India. A complete list together with a key, descriptions and their distributions have been drawn up with spe cial reference to the little known species. It has been found that out of 16 species occurring in India, 5 are endemic. The distribution of Indian Sphagnums in relation to their world distribution is discussed in the paper. The various economic uses of the genus with special reference to their absorbent property and as such their uses as a good substitute for bandaging in surgical operations have also been dealt with.

6. Sargassums of Indian Seas.

Kalipada Biswas and Arun Kumar Sarma, Calcutta.

Collection of this seaweed dates from as early a period as 1820. The total number of species recorded from Indian seas is 33. These are distributed along the coast lines of India and around the islands of the Indian Ocean, particularly the Andamans, the Nicobars and the island of Ceylon. There are 3 endemic species in India. A thorough description and a key to the different species of Indian Sargassums have been given in the paper. The range of distribution of these species has been delineated in the map. It has been observed that the Indian species show a greater affinity with the Pacific and Malayan ones. About 45% of the Indian species occur in the Pacific, 33% in the Malayan region and 6% in the East African coasts. The distribution of the Indian species of Sargassums against the background of their world distribution has been discussed in the paper.

7. Distribution of Indian Lichens.

Kalipada Biswas and Dharani Dhar Awasthi, Calcutta.

The total number of authentic species of lichens so far recorded from India is about 700, under 115 genera and 38 families. If the varieties and form are included, the number comes to 800. The records made are chiefly from the eastern and the western Himalayas, Bengal, Assam, Madras, Nilgiris, Ceylon and the Andamans. The picture of the distribution of Indian lichens though cannot at this stage be complete with many parts of India still lying unexplored, yet the preponderance of some families in a particular climatic zone can be clearly demarcated.

The temperate rain forest region of the east Himalayas are rich in foliose and fruticose lichens belonging chiefly to *Collemaceae Stictaceae*, *Peltigeraceae*, *Cladoniaceae*, *Permeliaceae*, *Usneaceae* and *Physciaceae*, while the subtropical and tropical belts of India, Ceylon and the Andamans are dominated by *Graphidaceae*, *Pyrenulaceae*, *Thelotremaceae* and others. Total number of endemic species is 316 confined to botanical regions of India and four small genera only are considered endemic.

Various ecological factors particularly the climatic factor mainly control the distribution of lichens in India. The tropical lichens, majority of which are crustaceous and squamulose bear close affinity to the allied species of the East Indies, Australia, New Zealand, Tropical America and Africa. The lichens of the temperate region show closer affinity to those of China, Japan, Europe and Temperate America.

8. The Cryptogamic collection of the Royal Botanic Garden, Calcutta.

KALIPADA BISWAS *and* DHARANI DHAR AWASTHI, Calcutta.

The Cryptogamic collection in the herbarium of Royal Botanic Garden, Sibpur, dates for a period of about a century and half. The collection is composed of good number of specimens of Algae, Fungi, Lichens, Mosses and Ferns representing different parts of the world. The liverworts are very few in nu mber. The ferns representing the collections of India and adjacent countries are too large for consideration in the present paper.

The approximate number of specimens in each of these classes of plants is Algae -3800, Fungi-2400, Lichens-3100 and Mosses-9000.Of these many are undescribed, unrecorded and some are even new to science. These are all being arranged in classified order with a view to treating each of these classes in detail separately.

It is hoped that the informatiom given in the paper will be helpful to those working in these branches of Botany. Type specimens of the different groups may kindly be sent as a gift or in exchange for their proper preservation to the Herbarium, Royal Botanic Garden, Calcutta,—the National Herbarium of India,—where Cryptogams along with the Phanerogams are receiving due attention.

9. On *Aspiromitus mamillispora* Bhardwaj Sp. nov., from Kandy, Ceylon.

D. C. BHARDWAJ, Lucknow.

In this note the author describes a new species of *Aspiromitus* St. (*Sp. Hep.* V,p 957, 1912-17), from kandy, Ceylon. The specimen was collected by Dr. S.K. Pande in December, 1939.

Dioecious, thalli small, more or less fan shaped, thin and soft, bearing mature sporogonia 20-30 mm long. Involucre 2-2.5 mm solitary; Spores dark brown, warty-mamillate about 40 microns. Elators brown, long, multiseptate, slender and unbranched. No male plants were seen.

10. A Preliminary Report on the Mushrooms of Baroda.

S. T. MOSES, Baroda.

The practice in cutch, where annually the Maharao receives the first mushroom crop - Use of mushrooms in *Gauri* Puja - Hints to distinguish between edible mushrooms and others - Puffballs, 'Horn of Plenty' and '*Chattri*' are other edible Fungi- Spores of mushrooms the chief clue to identification and their colour variations- Difficulties in collection and preservation - The food value of mushrooms and the imperative need for distinguishing the edible ones from the poisonous ones -Mushrooms to be used mixed with other vegetables, prawns, fish etc - Six selected recipes for curry, pickling, stew, savoury etc - Mushroom cultivation and fishculture- A tentative check list of mushrooms in the State—*Psaliotta*, (*Agaricus*), *Marasumus*, *Lepiota*, *Amanita*, *Coprinus*, *Hygrophorus*, *Volvaria*, *Pluteus*, *Hypholoma*, *Russula*, *Armillaria*, *Pleurotus* and *Psethyrella*.

11. On *Camptylonema indicum* Schmidle and *Camptylonemopsis* gen.nov.

T. V. DESIKACHARY, Madras.

The genus *Camptylonema* was established by Schmidle on an alga collected from Bombay, which he called *Camptylonema indicum*. This genus was placed by him under the Stigonematacea. Ghose and, following him, Geitler doubting the occurrence of true branches in the alga, transferred the genus to the Scytonemataceae.

An alga agreeing in all respects with *Camptylonema indicum* Schmidle was recently recorded by the writer from Cochin. This alga is considered by the writer the same as Schmidle's *C.indicum*. It possesses true branches in addition to false-branches. The genus is therefore retransferred to the Stigonemataceae.

Following Geitler's suggestion, a new genus, *Camptylonemopsis*, is created tentatively to include all those forms possessing crescent shaped filaments, but not showing true branches. This new genus is placed under the Microchaetaceae.

Three new species and two new combinations have been included under this new genus, *Camptylonemopsis*, viz., *C. pulneyenis* sp.nov., *C.minor* sp.nov., *C. Iyengarii* sp.nov., *C. lahorensis* (Ghose) comb.nov., and *C. Danilovii* (Hollerbach) comb.nov.

Phanerogams, Taxonomy and Ecology

12. Indo-Burmese species of *Grewia* Linn.

V. NARAYANASWAMI *and* R. SESHAGIRI RAO, Calcutta.

Much confusion exists in the synonymy of species of the genus, *Grewia* Linn. Specific limits of a large number of the Indo-Burmese species of the genus require re-orientation inspite of the critical work on the genus done during the past three decades. A complete revision of the genus has therefore become necessary.

The genus is mainly confined to the Tropical and Subtropical zones, Africa, claiming about 100 species and India and Burma, nearly 45 species. With the data collected we conclude that Africa has been perhaps the original home of *Grewia* Linn. from where, the lines of distribution might have proceeded first towards Peninsular India. From there, two diverging lines of distribution one to the North-east and the other to the South-east appear to have arisen.

As a result of our critical diagnosis of the genus, we agree with Burret in raising the two sections of the genus *Grewia* Linn, namely, *Omphacarpus* and *Microcos* to generic rank, namely, *Microcos* Linn. Confusions in groups, *Tiliaefolia* and *Hirsuta* have been elucidated. Our critical study of the three closely allied species, namely, *Grewia asiatica* Auct. (non.Linn), *G. subinaequalis D.C.* and *G. Hainesiana* Hole shows that they are all only Eco-forms of the common Indian wild species namely, *G. subinaequalis* DC. *G. asiatica* Linn. originally described from a garden plant at Surat (India), dose not seem to occur now in India. Nomenclatural revision of some of the species of *Flora of British India* has been carried out.

13. Revision of Indian Trapas.

KALIPADA BISWAS *and* JYOTIRMAY MITRA, Calcutta.

The systematic position of the Indian Trapas received not much attention of the Indian botanists so far. There are 5 species recorded from different parts of India. Of these *Trapa bispinosa* Roxb. and *Tarapa natans* Linn. are the most widely distributed species. *T. bispinosa* Roxb. is mostly confined to the plains whereas *T.natans* Linn. generally grows in the lakes, pools and puddles in the hilly region upto the elevation of 4,000 ft. in the foot of the Eastern Himalayas.

The distribution of the genus *Trapa* is rather limited being mainly confined to the old hemisphere as shown in the map.

Detailed examination of the Sibpur Herbarium specimens and other parts of the world, however, leads to modification of some of the conclusions hitherto arrived at on Indian species of the genus *Trapa*. Detailed investigation of the two species namely *Trapa bispinosa* Roxb. and *T.Maximowicksii* Kors has been undertaken together with a view to studying their internal morphological and cytological characters. Records of field observations on the genus in Bengal, the borders of Assam and Burma, Loktak lake, Manipur and South Burma, reveal interesting facts on the nature and growth of the species in different habitats.

Medicinal and economic importance of the species and possibilities of using the ruits as a substitute for food grains during scarcity have been discussed in the paper.

14. Observations on *Ipomoea biloba* growing in Benares.

N. K. TIWARY, Benares.

The author in this paper reports the thriving growth of the plant grown from seeds collected at Puri in 1935. But at Benares the plant flowers only during the winter season *i.e* Nov-Dec.Furthermere, no seed formation has been observed. Lastly, a few seeds from the lot obtained in 1935 were found to be viable after an interval of twelve years since they were collected.

15. On some features of Taxonomic interest in the Gamopetalae of Nagpur.

R. L. NIRULA, Nagpur.

During the last three years, the local Gamopetalous flora has been studied with the object of identifying all plants including the weeds, cultivated plants and forest shrubs and trees. During the course of this work, several features of interest were observed and the present communication is just to indicate only a few of them. (1) *Celsia coromandeliana*- At a spot in the old Nagnadi, behind the Maharaj Bagh Gardens, three types of plants were seen—the Normal plants, the Giant plants and the Dwarf plants. The Giant plants differed from the Normal ones in their greater height and larger leaves, while the Dwarf plants differed in their larger number of radical leaves and their larger size. In both, Giant and Dwarf plants, the inflorescence was never so long as in the normal plants. (2) *Justicia quinqueangularis, var. peploides*- The local specimens of this variety showed several characters suggesting that it serves as an intermediate form between the typical *J. quinqueangularis* and the typical *J. peploides* and that it should be retained as a variety and not raised to the status of a species as it has been done in some flora. (3) *Rungia repens* & (4) *Rungia elegans*- The study of both of these species (3) and (4) showed that these two should be combined into one species. Hooker had suggested that *Rungia elegans* is possibly the larger form of *R. repens* but all along, these have been treated as two distinct species in the different floras. These show very close resemblances and also some differences to suggest that they should be recorded as two varieties of the same species. One plant of *Rungia elegans* proved to be of extraordinary interest in this connection since on one side, it had the decumbent tufted habit of *R. repens*, while on the other side which was the major part of the plant ,it was erect with the branches quite away from each other like the typical *R. elegans*. Several more plants have proved to be of similar interest.

Morphology and Anatomy.

16. Confusion in systematic position in some of the Indian species of Rhododendrons.

KALIPADA BISWAS *and* R. SESHAGIRI RAO, Calcutta.

Rhododendrons received attention of the botanists from a very long period for the magnificent colour and texture of the flowers which are really the glory of the Himalayas. There are nearly 1250 species recorded from the different parts of the world. Of these India claims about 86 species, and of these again, nearly 84 species are in the Eastern Himalayas, 5 of which extending up to the North-western Himalayas, and Ceylon and Nilgiris have only one species each.

Field investigations reveal that there exists considerable confusion in the systematic position of the common species such as *R.campanulatum* D.Don, *R.Camelliaeflorum*, Hook.f., *R.cinnabarinum* Hook. f., and *R.Roylei* Hook.f.

The chief reason for such a confusion is the wide range of variations in the size of the plant, leaves and other morphological structures, number of flowers in each bunch, colour and texture of the flowers in the species, mainly due to their adaptation and acclimatization, different habit conditions and other ecological factors to which this genus is highly sensitive. Light, rainfall, snow-fall, temperature in higher altitudes, shade, particular hill slopes having favourable edaphic conditions, association with a particular plant community, such as *Viburnum* association, *Juniperus* association, *Abies Webbiana* association and others have definite effects on the large range of morphological variations in this genus particularly those growing in the Sikkim Himalayas. Detailed study clearly shows that there is sufficient scope yet to modify Hooker's descriptions and observations as recorded in some of his monumental publications.

An outline of the study of the genus from the systematic and ecological point of view is dealt with in the paper.

17. A survey of the Elephanta island flora.

MUHAMMAD S. KHAN, Kurla.

During 1943-44, Professor F. R. Bharucha of the Royal Institute of Science, Bombay and myself carried out a cursory survey of the floristic elements of the island. But since then it was thought to make a fuller survey and present a prospective view of the plant envelop to the visitors of the island who come in thousands to visit the caves for which the island is famous at present.

The paper gives a systematic list of the indigenous flowering plants of the island and describes the peculiar nature of the flora.

18. Leaf development at the growing apex and phyllotaxis in *Heracleum*.

GIRIJA PRASANNA MAJUMDAR, Calcutta.

The origin of leaf at the growing apex and phyllotaxis in development have been studied in *Heracleum*. The leaf originates in two stages, namely, (1) the Initiation, and (2) the Emergence.

The *initiation* takes place by the localized activity of the flank meristem on one side of the apex resulting in the formation of the *soubessement* (Gregoire), or the foliar foundation, *i.e.* the axial component of the primordium.

The *emergence* take place only after the desmogen strand, the future median trace of the emergence (the primordium), has differentiated up to the base of the foliar foundation. Intense activity starts in the corpus derivatives of the foliar foundation just ahead of the desmogen strand resulting in the organization of a core of meristematic tissue capped by 3 layers of tunica. Soon the smooth surface of the foliar foundation is "heaped up" and the foliar emergence has taken place followed closely by the desmogen strand as its median trace in the process of differentiation.

A leaf is thus composed of two parts : the axial component and the free limb, and these together make up the *phyton*, or the growth unit.

Heracleum has a 2/5th. phyllotaxis with a clockwise arrangement of the leaves. The angular divergence is 144°. Developmental studies show that this is true only on adult shoots. At the growing point the angular divergence is seen to vary between 144° and 160°, the widest divergence being noticed between the youngest primordia near the tip. The reason of these variations have been discussed.

Determination of the cause or causes responsible for the orderly apperance of primordia at the shoot apex, has been so far a speculation. Developmental studies offer a solution. Place of a primordium is primarily determined by the basifugally differenttiating desmogen strand which, separating from a lateral strand of a primordium down the axis, follows a definite course upwards and enter the new primordium as its median trace. Its origin and development precedes that of the primordium. The 'widest gap' is really provided by the formation of the foliar foundation.

Non-correspondence of the position of the abaxial fold or ridge with that of the median strand, and the unequal growth of the two sides of a primordium in the early stages of development, have been discussed.

Other points of interest in this connection, such as, number of primordia in contact with the axis at a time at the growing point, clockwise or anticlockwise, disposition of the genetic spiral have also been discussed in this paper.

19. The interpetiolar stipules of Rubiaceae with special reference to *Paederia foetida* Linn and *Ixora parviflora* Vahl.

GOPAL CHANDRA MITRA, Calcutta.

The developmental studies of the interpetiolar stipules of *Paederia foetida* Linn and *Ixora parviflora* Vahl show that the stipules in both the species are formed by the divergences of the product of the fused adjacent lateral extensions of the pair of opposite primordia from their bases. The fused portions of the stipule do not undergo any independent growth prior to their fusions. The formation and development of the stipule do not take place either by intercalary growth or by suppression of growth at the apices of the primordia.

In both the species the development, growth and divergences of the stipules from the bases of the primordia are influenced by the branches of the lateral traces of both

the opposite primordia which also form their vascular systems. And it is the course, orientation and formation of the vascular system of the stipules that determine their forms and shapes. The formation, courses snd orientation of the vascular systems of the stipules differ in the two species. No swelling of the bases of the primordia opposite the branches of the lateral traces is observed. The tissue of the stipules and the foliar primordia do not show similar features of growth and differentiation.

The stipules of both the species are composite stuctures both in respect of their tissues and vascular supply but they differ in developmental details.

20. Endosperm Development in *Lobelia Pyrimidalis* Wall.

K. SUBRAMANYAM, Bangalore.

The development of the endosperm in *Lobelia pyrimidalis* Wall. is *ab initio* cellular. The primary endosperm nucleus divides earlier than the egg. It divides just above the centre of the embryo-sac and a transverse wall is laid down thus forming an upper primary micropylar chamber and a long primary chalazal chamber. Next a vertical wall is first laid down in the micropylar chamber and this is soon followed by a similar type of wall in the primary chalazal chamber. Thus a 4- celled endosperm is formed. Sometimes the divisions in the two primary chambers are simultaneous. Subsequently, these pairs of cells become divided transversely, first the lower pair and then the upper; the result is an 8-celled endosperm is formed. Of these, two cells of the first tier develop into the micropylar haustorium, and the last pair of cells into the chalazal haustorium. The remaining two middle tiers form the endosperm tissue. The development of the endosperm thus follows the *Scutellaria*-type of Schnarf. The micropylar haustorium, which is made up of two uninucleate cells, persists for a long time in the mature seed and is more aggressive than the chalazal haustorium, which is also 2-celled.

21. The Development of the Female Gametophyte in *Lilium neilgherrense* Wight.

H. C. GOVINDU, Bangalore.

The hypodermal archesporial cell directly functions as the megaspore mother cell. The nucleus of the megaspore mother cell pass through the heterotypic divison, forming two daughter nuclei and these in turn undergo the homotypic divisons, thus forming a primary four-nucleate embryo-sac. No walls are formed around these nuclei. These four nuclei arrange in such a fashion that only one remains at the micropylar end, while the other three migrate to the chalazal end of the sac, thus showing the 1+3 arr angement. All the four nuclei divide simultaneously. The spindles of the three chalazal nuclei unite and a single bipolar spindle is formed. Thus as a result of this third division a secondary four-nucleate embryo-sac is formed with two haploid nuclei at the micropylar end and two triploid nuclei at the chalazal end. Now, three of these four nuclei, the two micropylar and the upper chalazal pass through the typical division; the fourth or the lower chalazal nucleus divides in an abortive manner. The mature embryo-sac shows a normal egg-apparatus, an upper polar nucleus, a lower larger polar nucleus and three antipodal cells; of these the two basal ones are smaller than the upper. Thus, the development of the female gametophyte in *Lilium neilgherrense* Wight conforms to the *Fritillaria*-type.

22. Prothalli of *Gymnogramme calomelanos* Kaulf.

T. S. MAHABALE *and* J. J. SHAH, Bombay.

The paper gives an account of the prothalli of this fern growing wild in the suburbs of Bombay. The prothalli are 0.2—0.5 cm in diameter and are green in colour. Their shape is extremely variable ranging from typical cordate or spathulate to something like cauliflower. In most cases they have 3-5 lobes around a central shaft arising from the spores. A few gemmae are also found in the midst of the lobes. The reproductive organs are also variously distributed. In small strap-shaped prothalli only antheridia are found whereas in the large prothalli either archegonia or both the archegonia and antheridia are found. The gemmae in some prothalli were replaced by apogamous buds developed near the notch. The cushion as a rule is either not distinct or is wanting.

The genus *Gymnogramme* is well known for its irregular prothalli and the present species adds one more instance to the two cases already known in the genus.

Study of the sporogenesis and anatomy is in progress.

23. Several-layered Tapetum in *Daemia extensa*, Br.

R. L. Nirula *and* P. D. Gadkari, Nagpur.

The family Asclepiadaceae has been studied embryologically by Stevens, Frye, Gager, Finn, Sabet and Pardi and a number of embryological peculiarities have been reported. Work on the local plants in Nagpur was undertaken to determine whether the features known so far characterise the family as a whole. In various respects, the study proved fruitful. In *Daemia extensa* there were observed two microsporangia in an anther, linear tetrads of microspores and a several layered tapetum surrounding the resting microspore mother cells. This became reduced to a two-layered jacket at the leptotene stage of the first reduction division and when the meiosis was complete, it was only one layered with much smaller cells. At the beginning of the pollinium development the tapetal cells increased in their size but finally they got disintergrated slowly and slowly. Throughout the whole process of spore development and pollinium formation, the tapetal cells remained uninucleate, a few binucleate cases having been observed only in the early stages of pollinium development.

24. Some new techniques in the study of the male gametophyte of the Angiosperms.

N. K. Tiwary, Benares.

The author gives an account of (1) a modified Carnoy's fluid in which instead of chloroform, sulphuric ether is used. This makes incorporation of colloidin, in the fluid, possible. This modified fluid can be used both for fixing the material as well as for making the material stick to the slides, thus facilitating subsequent manipulations without any risk of losing the material. (2) making up 1N/HCl in 9% alcohol instead of in water. This fluid is used as a fixing & a hydrolysing reagent & helps to avoid several difficulties of the customary technique employed in Feulgen reaction.

Physiology.

25. Hunger signs on Mango.

P. K. Sen, P. K. Roy, *and* B. N. De, Sabour, Bihar.

Nitrogen, phosphorus and potassium deficiency symptoms on mango, variety *Langra*, developed as a result of moderate and acute deficiencies of those elements in the nutrient solutions employed in a sand culture experiment have been described with coloured plates. The inter relation of these elements in mango nutrition has also been discussed. Plants showing the starvation effects could be brought back to normal health by replenishing the missing elements. The hunger signs thus determined would help to serve as a key in dealing with mineral deficiencies in soils of mango orchards.

26. Chemical studies in the physiology of mangoes.

S. C. Agarwala, Lucknow.

I—*Standardization of the conditions for the dry weight determination.*

The paper deals with experiments made to standardize the conditions for the determination of dry weight of mango fruits, at various stages of development and ripening. It has been concluded that results accurate to within 2% of the correct value can be obtained by drying the mango pulp at 60° for 24 hours in the case of mangoes during the period of growth and for 72 hours in the case of mangoes during the period of ripening.

IV—*Tannin in relation to necrosis of mango.*

The paper deals with the changes in tannins during growth and ripening of *Dasehri*, and *Safeda* fruits both from healthy and diseased orchards and due to necrosis in *Dasehrie Safeda* and *Fazli* varieties. The trend of the changes was found to be the same in the fruits from both the orchards. The significance of differences in the analytical resulte of necrotic and corresponding healthy fruits from diseased and healthy orchards have been tested statistically. The concentration was found to be significantly more

at the tip than in the other portions in the healthy as well as the diseased fruits of various stages. The concentrations in the diseased regions of the II, III and IV stages of necrosis were found to be significantly more than in the corresponding regions of the healthy fruits from the healthy as well as the diseased orchards in most cases. The tannins present in the mango fruits seem to belong to the pyrogallol and phlobatannin groups.

The changes in the concentration of tannins in growth and ripening of the mango fruits, the distribution of tannins in the different parts of the fruits and the known toxic effect of tannins on fungi, strongly indicate that tannins are responsible for keeping the fungi which have entered the green fruits latent till such time as ripening starts and for the differential tissue resistance of mangoes to the pathogenic fungi.

27. Penetration of mercuric chloride in some fruits (healthy and diseased) and its fungicidal action.

G. S. VERMA, Lucknow.

The paper deals with some experiments on rate of the penetration of mercuric chloride in peeled and unpeeled fruits, both in healthy and rotting condition.

Fungicidal action of mercuric chloride on some common rot-producing fungi, *e.g.*, *Fusarium* sp, *Rhizopus* sp, *Acrothecium* sp, *Aspergillus* sp, *Alternaria* sp etc. has also been studied on the host tissue and artificial culture.

28. On the formation of lesion by gases on mango fruits.

G. S. VERMA, Lucknow.

This paper deals with the effect of sulphur dioxide, ethylene and mixture of sulphur dioxide and ethylene on mango fruits with particular reference to the formation of lesions.

These gases were administered both to plucked fruits of some important varieties in the laboratory as well as in healthy orchards to fruits while still on the trees. The method of treatment of the fruits with gases was carried out either by giving a continuous current of desired concentration or by enclosing the fruits in containers with a fixed dose for definite periods. Experiments variously devised, have been described.

Sulphur dioxide gas produces brick-red coloured lesions round the lenticels on the general surface of the fruit. Heavy doses produce large dark brown patches through the coalescence of these lesions. At low concentrations, the number and size of lesions per unit area are roughly proportional to the amount of sulphur dioxide gas administered and to the period of exposure of the gas. It has , however, been found that below a certain minimum concentration of the gas no lesions are produced even though the period of exposure be very much prolonged.

A certain degree of difference in varietal susceptibility to gas effects has been found in the different varieties.

With very low concentrations (40 : 100,000) under laboratory treatment, the fruits showed shrinkage of tissues at the tip accompanied by change of skin colour. The shrinking of tissues was uniformly spread with slightly heavier doses.

This condition of the affected fruits in no way resembles the 'Black-tip' disease of the mango fruit.

In the very young condition, the lesions develop with 16 : 152,000 concentration which soon coalesce giving the entire fruit dark colouration causing ultimate dropping off.

Ethylene in low doses (1 : 10,000) induces ripening while slightly heavier concentrations (10 : 10,000) produce brown coloured lesions around lenticels all over the skin of the fruit. The spots or lesions increased in size as heavier doses were given. These spots coalesced forming dark brown patches on the skin of the fruit. A concentration of 3 : 100,000 and 5 : 100,000 produced no effect whatsoever when administered even for very prolonged periods.

The effect of sulphur dioxide and ethylene in admixture on the fruits was evidenced by the formation of dark brown lesions. The treatment with low concentrations under laboratory conditions induced ripening, and usual lesions appeared.

92. Preliminary studies on the effect of mineral nutrition on the gro wth and development of Jute plants.

J. C. SEN GUPTA, Calcutta.

Two species of Jute—*Corchorus Capsularis* (D154) and *C. Olitorius* (Chinsura green) were grown in sand cultures in glazed stoneware pots. There were 5 pots for each treatment and four plants in each pot *i.e.*, 20 plants per treatment.

The preliminary experiment reported here include :—

(1) Effect of three standard solutions : Hoagland, Knop and Richards with micronutrients. Sown on 23.4.45.

(2) Effect of sowing time on the relative influences of the three standard solutions. Sown on 23.5.45

(3) Effect of the omission of elements N,P,K. & Ca.

As the plants grow, the total heights, number of internodes, number of mature leaves on the main stem and number of leaves shed were recorded separately for each plant every week. In addition the flowering time and the fruiting time, the number of fruits per plant and number of seeds per fruit were also recorded. In the case of omission of elements the visual symptoms were also noted, the data being recorded as mean of the readings for each treatment.

Of the three standard solutions tried the best growth was found in Hoagland and next in Knop's. The worst growth was found in Richards. There were some differences in the effects in the two species.

The sowing time showed certain differences in the relative effects of the three solutions though not very pronounced, and showed a comparatively better growth in the control grown in soil in pots in the later sowings than in the earlier. The flowering was in general slightly delayed in the mineral solutions.

The heights etc. in the solutions without N,P,K & Ca and the visual symptoms are recorded. These effects are similar in the two species.

30. A comparative study of the catalase activity of the petals and leaves of *Hibiscus rosa-sinensis*.

S. N. PATTANAIK, Sambalpur.

In the present investigation, catalase ativity of the petals and young leaves of *Hibiscus rosa-sinensis* was determined in the morning, noon and evening of bright sunny days.

From the experimental data, it is clear that the catalase activity of the petals are less than the leaves. In case of the petals ,the catalase activity increased (very slightly) in the noon but a sharp rise is obtained in the evening ,when the flowers have started to fade. In case of the leaves the results obtained for catalase activity are different. In leaves the catalase activity is high in the morning and the values obtained in the noon and the evening are comparatively low.

31. A note on the tropisms shown by the aerial roots of Banyan.

N. K. TIWARY, Benares.

In this paper are recorded the author's observations on the tropic behaviour shown by the roots. Some of the roots grow along the surface of included lateral branches, instead of vertically downward, influenced by water trickling down the branches during the rainy season. Others grow vertically down, influenced by gravity. But the tips of these latter are always directed *away* from the direction of light rays & from a very characteristic feature.

Mycology and Plant Pathology

32. The chondriome in the genus *Phytophththora.*

B. S. Mehrotra, Allahabad.

1. The chondriome of the vegetative mycelium of the following eleven species of *Phytophthora* has been investigated.

(i) *P. Cactorum.* (ii) *P. Citricola* Saw. (iii) *P. Cryptogea* Pethybridge. (iv) *P. erythroseptica* Pethybridge. (v) *P. Faberi* (Faber) Maubl. (vi) *P. hibernalis* Carne. (vii) *P. paeoniae* Cooper et Porter. (viii) *P. fagopyri* Takimoto. (ix) *P arecae* (Coleman). (x) *P. Palmivora* Butler. (xi) *P. meadii* McRae.

All the three forms, *e.g.*, granular, rod shaped and filamentous mitochondria are present in varying proportions and the fungi may be divided into five groups according to the kind of mitochondria present *viz.* :—

(i) Mostly granular	*e.g.*	*P. Faberi* (*Faber*) Maubl.
(ii) Mostly rod shaped	*e.g.*	*P. Cactorum.*
(iii) Mostly filamentous	*e.g.*	*P. Citricola* Saw.
(iv) Granular & rod shaped mixed.	*e.g.*	*P. arecae* (Coleman).
(v) Granular, rod shaped & filamentous mixed.	*e.g.*	*P. cryptogea* Pethybridge.

2. The mitochondria are seen as long, filamentous and slender bodies of varying length lying mostly parallel to the longitudinal axis and constantly moving under the influence of the cytoplasmic currents. At the tips they are granular in shape.

3. Janus green Höcht B and dahlia violet stain them, transforming them into vesicles. The vacuolar system and the mitochondria are stained simultaneously by using a mixture of neutral red and Janus green.

4. Of all the fixatives employed Holly's liquid and Sublimé formol gave good results. Liquid of Lenhossek (containing alcohol and acetic acid) did not produce any marked change.

33. Carbon requirements of the genus *Pythium.*

R. K. Saksena *and* B. S. Mehrotra, Allahabad

1. The growth of the following species of *Pythium* on different carbohydrates and alcohols was quantitatively measured under controlled conditions :—

(1) *P. afertile* Kanouse et Humphery.	(9) *P. epiphanosporon* Sideris.
(2) *P. aphanidermatum* (Eds.) Fitz.	(10) *P. graminicolum* Subramaniam.
(3) *P. arrhenomanes* Drechsler	(11) *P. hyphalosticton* Sideris.
(4) *P. artotrogus* (Mont.) de Bary.	(12) *P. leucosticton* Sideris.
(5) *P. de Baryanum* Hesse.	(13) *P. mamillatum* Meurs.
(6) *P. de Baryanum* Pelargonii.	(14) *P. polymeron* Sideris.
(7) *P. deliense* Meurs.	(15) *P. spaniogamon* Sideris.
(8) *P. diameson* Sideris.	(16) *P. rhizophthoron* Sideris.

2. The fungi did not grow on medium lacking in the source of carbon.

3. Dextrose, maltose, sucrose and starch were found to be the best sources of carbon for these fungi.

4. The utilization of the polysaccharides was correlated with the ability of the organism to hydrolyze them.

5. In majority of the media containing various carbohydrates singly, the acidification was noticed with the growth of the fungus. But in case of media containing sucrose and starch the acidification was very little.

Economic Botany

34. Economic plants of the Darjeeling District.

Kalipada Biswas *and* Jyotirmay Mitra, Calcutta.

India is extremely rich in economic plants. Vavilov is fully justified in stressing that from the unknown cradle of the South Asia might be discovered many plants for our economic uses. The writers' long search and enquiry into the uses of hundreds

of useful Sikkim species of the district of Darjeeling leads to the discovery of marvellous medicinal effects of some of the indigenous species. Many temperate crops are also grown in the district and these were introduced and acclimatized in this hill region. Thorough investigation into the uses of these economic plants has been undertaken and the present paper deals with the most common species numbering about 50, of which very little is known.

35. Possibilities of the Manufacture of Rose Oil in India from the roses cultivated in India.

KALIPADA BISWAS *and* PROMODE RANJAN BANERJEE, Calcutta.

The Essential Oil Committee of the Council of Scientific and Industrial Research entrusted the senior author with the investigation on Roses. The bulk of the Rose Oil amounting to about Rs. 600,000/- used to come mainly from Bulgaria before the war. Here in this part of the Eastern Europe large plantations are set apart and rose oil is manufactured on a commercial scale. It is hoped that if rose oil can be manufactured in India it might be possible to encourage the rose growers to undertake extension of their rose plantations on a large scale and save waste of large quantity of petals by setting up small factories in the garden with a view to making India at least self-suppporting to a considerable extent with regard to her needs of rose oil used for various purposes in trade.

The work is for the time being confined to Bengal and Bihar. There are about 6 species of commercial varieties sold in the market under cultivation at present apart from numerous varieties grown for the garden purpose.

Collections in Bengal show that wild species of Roses are *R. macrocarpa* & *R. sericea* Lindl. *R. marcrocarpa* is an extremely valuable rose for texture and attempts are being made by horticulturists in U. S. A. and elsewhere to get a hybrid of a very high quality and price from this middle Himalayan rose.

Regarding the chemical aspect, a considerable percentage of Ascorbic acid (Vitamin C) has been detected in the hips of some particular varieties of rose from the Sonthal Pargana districts. Also a very efficient acid-alkali indicator has been isolated from the colouring matter of another particular variety of rose. Work on these aspects of the chemical investigation of rose are in progress.

36. South Indian seaweeds of economic value.

FRANCESCA THIVY *and* S. V. GANAPATI, Madras.

Because seaweeds supply necessary salts, including iodine compounds, in readily available organic form and furnish vitamins they should have a place among common foods. In China, Japan and the Hawaiian Is. over a hundred kinds are thus utilized. Luscious and wholesome "sea vegetables" of South India include green, brown and red algae.

Whereas *Gracilaria lichenoides* (L.) Harv. is the only agarphyte commercially employed in India, investigation shows seven other species, in three genera, yielding good percentages of agar, are available in abundance.

Textile sizers obtained from *Grateloupia* and *Acanthophora* are suitable for industrial adoption.

Padina, Turbinaria, Cystophyllum, Sargassum, Hormophysa as well as smaller algae thrown up in the wash have possibillities for fertilizer and stockfeed utilization.

Taxonomy of the species as well as methods of extraction and industrial uses of the phycocolloids dealt with are considered.

37. On the development of nodal bacterial root tubercles in the floating branches of *Neptunia oleracea* Lour.

T. J. JOB *and* FRANCESCA THIVY, Madras.

The plant is an aquatic perennial anchoring itself to the margins of tanks and producing densely growing floating branches. On the latter clusters of adventitious

roots occur which are suspended in the water and in each cleustr develop oval, pink tubercles about 1 mm. in diam. and 2 mm. long, singly or in groups. The soil roots exhibit only a few tubercles, which though similar to the others often growing larger become branched and turn dark brown in colour

The tubercles of both types of roots are found to be densely packed with rod-shaped and often curved or undulate bacteria about 0·7 μ in diam. and 1·4 μ to 7·0 μ long. The plant being a member of the Leguminosae, the organism associated with the soil roots is presumably the symbiotic nitrogen-fixing bacterium, *Rhizobium radicicola*. Since the bacterium in the tubercles of the floating branches and that of the soil roots are morphologically similar, it is probable they are identical. Cultures of the bacterium are being grown on nitrogen-free media.

Probably *Neptunia oleracea* has vital significance in agricultural practice.

38. Some aquatic macrophytes of importance as fish forage.

FRANCESCA THIVY, Madras

In South India the macrophytic hydrophytes in fish ponds are, as a rule, limited to *Chara* spp., *Hydrilla verticillata* Presl., *Vallisneria spiralis* Linn., *Najas* sp., *Ceratophyllum demersum* Linn., *Nymphaea pubescens* Wild. and *Nelumbium speciosum* Wild. Great variety in diet is one of the striking facts about the feeding habits of fish and therefore increased numbers of species of forage aquatic plants should be impressed into the service of pisciculture.

At "Fishlands", Madras, the following hydrophytes which are useful as fish forage have been introduced into the ponds from other parts of the Province and North India : *Nasturtium officinale* R. Br., *Limnanthemum cristatum* Griseb., *Ipomaea aquatica* Forsk., *Ottelia alismoides* Pers., *Ottelia* sp., *Pistia stratiotes* Linn., *Lemna paucicostata* Hegelm., *Spirodela polyrhiza* (L) Schelid., *Wolffia michelii* Schleid., *Wolffia microscopica* Kurz., *Najas graminea* Del., and *Lagerosiphon Roxburghii* Benth.

The ecology and methods of culture of the above species are discussed.

39. Aquatic vegetable gardening in fish farms.

FRANCESCA THIVY, Madras.

Most aquatic vegetables are neglected although in many of them are brought together both aesthetic appeal and special food values, such as, high content of calcium, phosphorus, iron, provitamin A, vitamin C or proteins. Production is economical in cost, labour and time.

Aquatic and semi-aquatic vegetables belonging to over a dozen different species have been grown at " Fishlands ", Madras, including water-cress, amaranth, morning glory and garden mint.

The taxonomy, ecology, methods of cultivation, and collated food values relating to the above are presented.

40. Culture of *Bacillus radicicola* with the object of isolating a rapidly nitrogen fixing strain.

R. L. NIRULA, Nagpur.

It is hardly necessary to emphasise the importance of *Bacillu radicicola* which is so well-known. This has been the subject of a large number of investigations from different stand-points. The most inportant out of these is the soil inoculation or seed treatment with the organism and has a considerable economic value. The present work was started at Nagpur with the object of culturing *B. radicicola* on a large number of artifical media in the laboratory and isolating,if possible, strain or strains which would be "fixed" *i.e.* undergo no loss of virulence or vitality and possess the ability of fixing, larger quantity of atmospheric nitrogen.

The pea plant was used for the investigation and eight strains have been isolated from a parent strain that originally came from a single cell. Two of these are "fixed " and grow more actively. These might prove to be the requisite ones. The different strains including the parent were cultured on a large number of media. They showed several colony differences and differed in the liquid media with regard to the speed of their reactions ; but in respect of the nature of these they were fundamentally similar. The results obtained so far appear to be very hopeful in the direction of evolving a quick nitrogen fixer and in the direction of solving the perplexing question of species.

The methods used during culturing were, iu additien to the poured plste and Dr. Paine's and Burri's method as modified by the writer for the isolation of single cells, those employed ordinarily in mycological studies.

The different strains had always originated as sectors in the parent colonies or those of the strains on solid media.

41. Inter-specific and Inter generic crosses between *Luffa* and *Trichoranthes*

R. H. Richharia, Sabour, Bihar

Inter-specific cross between *L. aegyptiaca* and *L. acutangula* has been made and the F_1 used as ♀ to cross *Trichosanthes angniua* which also succeeded. It may be added that attempts to cross *T. angniua* with either of the parents *viz.*, *L. aegyptiaca* and *L. acutangula* did not succeed.

SECTION OF PHYSIOLOGY

PRESIDENT : DR. BASHIR AHMAD, M.Sc., Ph.D. (Lond.).

Pharmacology

1. Pharmacology of Polyporin—A preliminary report.

B. B. ROY *and* B. MUKERJI, Calcutta.

Polyporin represents the culture-filtrate of *Polystictus sanguineus* grown in various media (Bose, S. R., Bull. Bot. Soc., Bengal, April, 1947). Three different filtrates (F. 163—Broodlac medium; F. 164—Wheat husk medium; F. 168—Paddy husk medium) have been studied. In *intact* anaesthetised (urethane) animals (dogs and cats), the filtrates produced, in moderate doses (0·25 to 0·5 cc./kg. intravenously), only a slight fall of blood pressure, returning quickly to normal. Heavier doses caused a slightly increased fall in pressure, which, however, was not significant (10 mm. of Hg. with 1 cc./Kg.). In the *spinal cat*, the fall in blood pressure was comparatively greater (about 20 mm. of Hg). Of the three filtrates tested, F. 164 caused the greatest, and F. 168 the least amount of fall. The respiratory effects followed closely the blood pressure changes showing augmentation during the period of fall returning to normal with the restoration of the pressure to the original level.

No untoward symptoms were observed when the different filtrates were injected intravenously in unanaesthetised rabbits in doses of 1 cc./Kg. Neither was there any effect when the filtrates were instilled in the rabbit's cornea. Virgin guineapig's uterus was indifferent to the action of the crude filtrates in isolated bath experiments.

The changes noted above do not appear to arise from polyporin itself since comparable results were obtained with the administration of the respective blank media alone.

2. A Note on the Pharmacology of *Securigera Securidaca*.

M. L. CHATTERJEE *and* B. K. GHOSH, Calcutta.

A bitter principle from chloroform extract of the drug was isolated by S. Ghosh and N. N. Ghosh and its pharmacological action was studied by P. De. Besides the bitter principle contained in the chloroform extract of the drug, another bitter principle has been found in the alcoholic extract which was isolated and the pharmacological action was studied in cats under chloralose and urethane anaesthesia and under spinal operation.

Dose used was 0.05 mgm/kgm to 0.5 mgm/kgm.

This bitter principle acts by direct stimulation of the plain muscle of blood vessel and raised the blood pressure but is depressant to the cardiac action. Urethane seems to add to the toxic effect of the principle on the heart.

Its action on uterus and intestine is by stimulation of activity.

The seat of action of this bitter principle is different from the other principle studied by Ghosh & De.

3. On the Assay of Liver Extracts.

A. N. BOSE, Baranagar, Calcutta.

There is no definite laboratory method for evaluating the potency of a liver preparation meant for parenteral administration. An investigation has, accordingly, been carried out for finding out an idea regarding the efficacy of liver preparations by administration into guineapigs of definite weight put up in uniform fixed diet. Animals whose reticulocyte percentages show minimum fluctuation and vary between 0.5 to 0.8% were selected and injected with various preparations. Counting was followed for 7 successive days, and the days after injection of minimum quantity of the preparation that gave the optimum response were recorded.

In our hands the above assay of a liver preparation is giving a fair indication of the potency of a liver extract whether made from the whole liver, by fractionation or by proteolysis.

4. Phytopharmacological Studies of Gonadotropic Hormone in the Pregnancy Urine.

J. S. CHOWHAN, Calcutta.

A mention has been made in Ayurveda, on the determination of pregnancy in different stages by the use of pregnant woman's urine as a manure on black horse gram grown in earthen pots. Some interesting study has recently been made on the effect of menotoxin, leprosy serum and vegetable alkaloids on the growth of young seedlings. A study on the effect of gonadotropic hormones present in the urine of pregnant women was taken up in this laboratory on the above lines. So far it is seen the gonadotropic hormones appear to have some effect on the rate of the growth of the seedlings. It cannot be stated at present if the above study will be a substitute to the well known Aschheim and Zondek test and the Friedmann test. The advantage of this test will be that the results could be obtained within 24 to 48 hours and no animal life will be sacrificed.

5. Effect of common salt on gastric secretion.

BINDESRI PROSAD SINHA, Laheriasarai, Darbhanga.

An experimental study on the Pavlov and Heidenhain pouch dogs on the effect of common salt (1·5 gm) orally, demonstrated an inhibitory effect in the quantity of the gastric juice, thus differing from the secretagogue behaviour of sodium chloride (Babkin). On further observation of the associated inpurities present in the common salt independently, it was found out that the magnesium chloride and calcium chloride particularly were responsible for the inhibitory effect of common salt. Calcium chloride itself in 1·5 gm. oral administration had a remarkable inhibitory effect in both the quality and quantity of the gastric juice.

6. Effect of atropine sulphate on gastric secretion.

BINDESRI PROSAD SINHA, Laheriasarai, Darbhanga.

An experimental study on the effect of Atropine Sulphate by parenteral route, on the combined observations on Pavlov & Heidenhain pounch dogs and on Heidenhain dogs alone, had a marked inhibitory effect in the quality and quantity of the gastric juice, in both the conditions. In Pavlov animals alone, it was usual to have so, whereas in Heidenhain (due to non-existence of vagi), the observation was unusual. An interesting conclusion was made that in Pavlov, atropine sulphate prevented the entrance of acetylcholine into the main stomach, so there was an inhibition in quality (in acidity) and quantity of the gastric juice, obtained through the pouch. Whereas, in Heidenhain acetylcholine was not liberated due to non-existence of parasympathetic innervation or the usual amount of acetylcholine formation was going and was not acting in the pouch due to atropine sulphate.

7. India Aconite.

R. C. GUHA, Calcutta.

Aconite is considered to be sufficiently important drug to be included in the Indian Pharmacopoeial List, 1946, by the Government of India from the Department of Health. But as not much data is available on the Indian Aconite, only characters, acid-insoluble ash content & biological assay without any standard, are given in the monograph. Therefore the monograph for Indian aconite requires further data for the complete evaluation of the drug. In the present investigation, a standard has been suggested on the basis of the chemical analysis of the different varieties of the drug. At least 70 species of aconite are known to be grown throughout the world and of them generally 6 or 8 species of aconite occur on the Indian market. Since various considerations have been emphasised by many workers that the physiologically active constituents of the numerous species of aconite require separate and special investigation, six different varieties were collected from the Indian market for the complete chemical analysis of the drugs to the toxicity of the drug. It was reported (Report of Poisonous Sub-Committee, 1942) that more consistent results obtained when assays were based upon the total alkaloidal content rather than the ether-soluble portion.

The average total alkaloidal content of the six different varieties of Aconite was found to be 2·1%, the maximum concentration 3·11% was being observed in the case of *Aconite chasmanthum* while the average acid-insoluble ash was found to be about 0·52%. Therefore it was suggested that the total alkaloidal content calculated as aconitine should be not less than 1·0% & acid-insoluble ash should be not more than 0·5%. Futher work is in progress.

8. The effect of 4 : 4′—Diamidino Stilbene on the Nucleus of the Fifth Nerve of the Rhesus Monkey.

P. C. SEN GUPTA, Calcutta.

The lesions compatible with the clinical features of Diamidino stilbene Neuropathy in man have been produced in the rhesus monkey.

9. Benadryl—in the Treatment of Viper Bites.

J. S. CHOWHAN, *and* D. P. GHOSH, Calcutta.

In our previous studies the injection of pituitrin and veritol has been advocated in the treatment of acute and chronic Viper Venom poisoning or after the secondary shock that follows Viper bites. The Viper Venom acts mainly on the circulatory system and the collapse that follows is histamine-like in nature. Benadryl (beta-dimethylaminoethyl benzhydryl ether hydrochloride) is reported to have a remarkable anti-histaminic activity. The effect of Benadryl was tried in collapse produced by Russells Viper Venom in experimental animals. The blood pressure returned to normal and the respiratory distress was relieved with small doses of Benadryl, injected intravenously in such animals. Benadryl could neutralise the effect of Viper Venom when injected mixed with the venom or when it was injected immediately after a big dose of viper venom.

It is suggested that Benadryl in doses of 50 to 100 mg. by mouth and injected intramuscularly or even intravenously will be useful as an antidote in the case of Viper Venom poisoning in human beings.

10. The Therapeutic Use of Sea Water in Scabies and Other Skin Conditions.

J. S. CHOWHAN, Calcutta.

Quinton and Macallum, long ago, pointed out that in a great majority of animal the circulatory fluid and the body juices, from its inorganic composition, is but a representative of sea water. The present terrestrial and the avian lives are but descendents of forms that once lived in the sea. In view of the above observations that the sea water and the body juices are allied in their Na, K,Ca and Mg constituents, the parenteral use of sea water was tried and found useful in cases of mental disturbances, canine mange and ring worm in animals. Deep subcutaneous injections of sterile sea water in doses of 2 to 3 c.c. were injected daily in patients suffering from Scabies. In 280 cases so far treated with different doses of sea water 34·3% showed a clinical improvement and 28·5% showed marked improvement. The improvement was noted in the shape of relief in severe itching, drying up and scabing of the rash and later on peeling off of the rash. Sea water therapy promises to be useful in many other skin and general conditions. It has the advantage over the time old sulphur treatment that the treatment is not messy and the resources of the drug are enormous and easily available. The treatment is harmless.

11. Toxic symptons due to rauwolfia serpentina

NAGENDRANATH DE Calcutta.

Rauwolfia serpentina has no official dose. It has been used for a long time in the indegenous systems of medicines in India. Recently it is being largely used in cases of high blood pressure and some mental diseases. The dose used for high blood pressure is about 70—100 grains of the powdered root or the corresponding amount of the total alkaloid liquid extract daily. The dose for mental diseases is about 3 times as much. Toxic symptoms are often observed with these therapeutic doses.

Parkinsonism is one of these toxic symptoms. Bradycardia and congestion of the face, conjunctiva and nasal mucous membrane are others. The action of the drug on tne human system is mainly one of depression. Depression of the brain specially at the subcortical level is probably the cause of the beneficial action of the drug in mental diseases. Extreme depression of the globus pallidus is perhaps responsible for the parkinsonian rigidity. Slowing of the heart and congestive phenemena are likely to be due to depression of the sympathetic nervous system.

Biochemisty and Analytical Chemistry

12. A Chemical Method of Estimation of Nicotinic Acid in Urine in the presence of Sugar.

SACHCHIDANANDA BANERJEE *and* NARESH CHANDRA GHOSH, Calcutta.

Various methods have been proposed by different workers for the estimation of nicotinic acid in urine by Konig's reaction. When all these methods were tried in the urine of diabetic patients it was impossible to estimate the nicotinic acid of the urine due to the interferring colour which was produced after digestion of the urine due to the charring of the sugar present. In studying the nicotinic acid nutrition of diabetic patients a method for the estimation of nicotinic acid in urine in the presence of sugar was necessary. The method developed by us is as follows: Sugar in the urine is quantitatively estimated with Benedict's reagent. To 25 cc. of urine in a 250 cc. beaker is added 8 cc. of concentrated hydrochloric acid. The beaker is heated in a water bath and is treated with 10 per cent potassium permanganate until all the sugar is oxidised. The manganese present in the solution is removed as phosphate by treatment with disodium hydrogen phosphate and caustic soda. The solution is then digested in water bath for 45 minutes with 40 per cent caustic soda so that the strength of the alkali is 4 per cent. Interferring colour is removed by making the solution acidic with concentrated hydrochloric acid and treating with potassium permanganate solution until the solution becomes almost colourless. The solution is adjusted to pH 7, phosphate buffer is added and the precipitate formed is filtered. An aliquot of the filtrate depending on the amount of nicotinic acid present is taken for the colorimetric estimation of nicotinic acid.

13. Effect of Nicotinic Acid Amide on Blood Sugar and Blood Acetone Bodies of Diabetic Patients and of Normal Subjects.

SACHCHIDANANDA BANERJEE *and* NARESH CHANDRA GHOSH, Calcutta.

Contradictory reports appear as to the efficacy of nicotinic acid in the treatment of diabetes. In view of the conflicting reports and in view of the observation that nicotinic acid prevents the diabetogenic action of rabbits and rats as shown by Banerjee (*Science*, 1947, 106, 128) it was thought desirable to study the effect of intravenous injection of nicotinic acid amide on the blood sugar and blood acetone bodies of diabetic and normal subjects,. 500 Mg. of nicotinic acid amide in a 10 per cent solution was injected intravenously in 17 diabetic and 6 normal subjects fasted overnight. Samples of blood were taken before and at intervals of half an hour upto two hours after the injection. Blood sugar and total blood acetone bodies were determined and it was found that nicotinic acid amide had practically no effect on the blood sugar and blood acetone bodies in diabetic and normal subjects.

14. Anti-Diabetic Sugar.

PRAHLAD ROY *and* DIPTENDU GANGULY, Calcutta.

The result of investigations in the Indian Institute for Medical Research indicates that Sucrose or Glucose when treated with milk of lime and phosphoric acid is absorbed and utilised by animal or human system under diabetic conditions, unlike normal sugar or sugars subjected to any other treatment with milk of lime and carbonic or sulphurous acids.

In normal system the rate of absorption of the Treated Sugar (milk of lime and phosphoric acid) has been found to be more rapid than in the case of the ordinary sugars.

Further study is being made to compare the difference between the hepatic glycogen reserves of the animals after administering theTreated and Normal Sugars.

15. Deterioration of the Vitamin B_1 Content of Malt-Extract Stored in the Tropics.

N. K. IYENGAR *and* B. MUKERJI, Calcutta.

2 standard samples of Malt extract with vitamin B_1 contents of 300 and 200 I.U. per gram respectively were stored in the laboratory for a period of one year from October 1946 to 1947 covering all the seasons of the year. They were tested

periodically by employing the Decalso adsorption method once in 2 months and a progressive deterioration was observed. At the end of one year a loss of nearly 40 per cent was recorded. The malt extracts were prepared by evaporating in vacuum at a temperature of less than 50 °C. A sample of malt extract prepared by evaporating at a temperature of 85°C and whose vitamin B_1 content was 125 I.U. per gram, was also tested for deterioration when stored under similar conditions. At the end of one year the loss in this case was only 25 per cent. This is probably due to the destruction by heat in the latter case of enzymes present in malt extract, capable of inactivating vitamin B_1.

16. Protective factors for Vitamin C in green-gram (*Phaseolus radiatus*).

SUDHA DEVLALKAR *and* K. V. GIRI, Bangalore.

The occurrence of enzyme systems and other factors which influence the formation and destruction of vitamin C in green gram during germination has been investigated.

The results indicate the occurrence of the following factors in the seed.

1. A reducing system which reduces dehydro-l-ascorbic acid into ascorbic acid in the absence of added glutathione in the intact seed during germination. In presence of dehydro-l-ascorbic acid therefore more vit-C is formed during germination.
2. An oxidative factor which oxidises vitamin C. This factor develops during germination.
3. A protective factor which protects vitamin C against autoxidation and copper oxidation but not enzymic oxidation. In germinated seeds, as a result of the action of the oxidative factor on vitamin C the protective action of the factor is not very pronounced. Destruction of the oxidative factor by boiling however enhances the protective action.

Further investigation on the inter-relationship between these factors with respect to the formation and destruction of Vitamin C during germination of green gram and other pulses is in progress.

17. Effects of light and manganese on the synthesis of ascorbic acid and ascorbic acid oxidase during germination of cereals.

INDERJIT *and* BASHIR AHMAD, Delhi.

Light has been found to have a striking effect on the synthesis of both ascorbic acid and ascorbic acid oxidase during the germination of barley, green gram, millets and Bengal gram. Both these increased side by side and the increase was further augmented by the presence of a trace of manganese.

18. Preliminary observations and discussions on biochemical findings in human cases of liver cirrhosis with particular reference to choline content in blood.

A. DAS, S. M. BANERJI *and* R. SUBRAHMANYAM, Cuttack.

Biochemical changes in blood in clinical cases of liver cirrhosis at the Orissa Medical College Hospital have been investigated and diminution of blood proteins, reversal of *albumin-globulin* ratio and marked diminution of lipide phosphorus have been found. The significance of the last change is discussed and the estimation of lipide phosphorus is suggested to determine the choline deficiency. Further investigation in these lines may lead us to a new liver efficiency test in cirrhosis of liver. Etiogy of liver cirrhosis in human cases may be due to lack of choline in diet and choline therapy is therefore sugggested as a rational treatment.

19. Enzyme Destruction and Color Retention in Dried Prunes.

C. N. CHARI, C. P. NATARAJAN, H. J. PHAFF *and* E. M. MRAK, California.

Dried prunes removed from the dehydrater at a moisture content of 30 to 32 per cent and packed in moisture proof containers with propylene oxide to prevent microbiological deterioration will discolor and attain an off flavor. Experiments were conducted to determine factors involved in the development of off flavor and discoloration. It was observed that peroxidase is responsible in part at least for these changes. Prunes were dehydrated under various conditions of counter flow and

two-stage systems of drying in an effort to destroy the peroxidase enzyme. Thermocouple measurements were made to follow the temperature of the prune flesh near the pit. Even though the flesh was heated to over 200° F. several hours during the two-stage drying, the enzyme was not completely destroyed. In view of this the possibility of obtaining enzyme destruction by changing the system of dehydration was abandoned, and steam blanching of the freshly dried prune was tried. It was found that peroxidase in freshly dehydrated prunes containing 30 to 32 per cent moisture could be inactivated by blanching the fruit in live steam for about 6 minutes. Thermocouple measurements indicated the temperature of the prune flesh was all above 200° F. in this period of time. Tests for the presence of catalase, phenolase and peroxidase indicated that these enzymes had been inactivated by the treatment. The fruit was then packed in moisture proof bags, treated with propylene oxide to prevent microbiological deterioration. After a period of storage for 3 months at 80° F. the color and flavor retention of the blanched samples were much superior to those of the unblanched samples. The procedure is recommended as a method of production and packing of dried prunes of a superior quality.

20. On the measurement of the Proteolytic activity of Enzymes.

N. Roy, Baranagar, Calcutta.

Various methods are now known for the determination of the proteolytic activity of the enzymes pepsin, papain and trypsin. The methods should indicate the nature of the enzymic activity as a protein may be degraded from protein through various stages to amino acids. In routine procedure however an easy method for estimating the lipuefying power of a proteolytic enzyme is of more significance for commercial evaluation.

The method of estimating the liquefying power of pepsin, papain and trypsin against casein has been simplified and relative unit has been (66, 13 and 25 respectively) indicated for each enzyme.

21. Effect of long continued administration of some fat metabolism products on the potency of pancreatic insulin of guineapigs.

M. C. Nath *and* H. D. Brahmachari, Nagpur.

Intermodiary fat metabolites such as hydroxy butyric acid & aceto-acetic acid when injected into normal guinea pigs in the form of their Sodium salts, have been found to cause decrease in the potency of their pancreatic insulin.

Insulin was extracted from the pancreas of the experimental animals at regular stages and assaying was done on normal rabbits according to the usual method.

Though during the 1st stage of the experiment a considerable rise in the potency of the pancreatic insulin was observed in the experimental animals, the insulin potency was found to be greatly decreased after a period of about 2 months' injection.

22. The milk-coagulating enzyme of the latex of *Ficus carica* Linn.

C. R. Krishnamurti *and* V. Subrahmanyan, Bangalore.

A systematic search among plant sources for a suitable substitute for rennin was carried out and the latex of *Ficus carica* Linn (Edible fig) was found to be a very promising source. Freezing of the latex filtrate followed by quick evaporation under vacuum gave best yields of enzyme of very high activity . Preparations capable of coagulating nearly a million times their own weight of milk under optimum conditions were obtained. The physico-chemical properties of the enzyme and kinetics of milk coagulation were studied. The enzyme was found to be more versatile than animal rennet. Of special interest was its positive coagulating effect on vegetable milks like those from soya-bean which failed to respond to the action of animal rennet. The plant enzyme gave cheeses comparable in texture and qualities to those made out of animal rennet.

23. The Proteolytic Enzyme of the latex of *Ficus Carica* Linn.

C. R. Krishnamurti *and* V. Subrahmanyan, Bangalore.

Although the enzyme preparation from the above latex was several times more active than the best available brands of animal rennet, it gave cheeses which developed slightly bitter taste after ripening. The bitter taste was found to be due to the products of proteolysis resulting from the action of a protease component in the enzyme

preparation. With a view to ascertain the nature of the protease and to devise methods of suppressing its pronounced action in cheese-making the enzyme was studied in detail.

The enzyme gave characteristic protein reactions and was found to resemble papain in ultrafiltration, diffusion and dialysis studies. Unlike papain, however, it had no blood-clotting action. The enzyme was found to be tryptic in nature and was active on casein, edistin, egg-albumin, haemoglobin, peptones and synthetic substrates like Hippurylamide. The urea denatured proteins had a higher degree of digestibility than the aqueous solutions of proteins. The digestion of casein and haemoglobin both in water and urea were found to be second order reactions. Temperature inactivation of enzyme was also a second order reaction. The behavior of the enzyme towards oxidizing and reducing agents was similar to that of papain.

By fractional precipitation of the enzyme with alcohol the enzyme components could be separated. The milk-clotting, casein-splitting and gelatinase activities increased with the nitrogen content of the fractional precipitates, whereas, the peptonase activity diminished with the nitrogen content.

24. Effect of feeding thyroidal and antithyroidal substances in sheep.

D. N. Mullick, Izatnagar.*

Weekly blood was analysed for haemoglobin, sugar and serum for protein, fat, calcium,phosphorus and magnesium in thyroidectomized and control animals for thirteen weeks. Standard methods were followed with the progress of time after operation all the constituents in experimental animals changed but the fat content in serum decreased significantly.Now the experimental group was fed with synthetic thyroprotein at1gm/100 lb body weight for 3weeks and afterwards the dose was increased to 2g/100 lb body weight All the constituents were analysed and the fat content in serum was still reduced. The control animals were supplemented with thiouracil at 8g/100 lb body weight for 5 weeks. All the constituents were analysed and the fat content was increased considerably and the change was significant. From these observations we concluded that the fat in serum could be properly utilised for the actual doses of thyroidal and antithyroidal substances in order to avoid the bad effect in animals health.

25. A Preliminary Study of the Deterioration of Water Soluble Alkaloids of Ergot.

B. K. Ghosh, Calcutta.

It has been found that the Ergot preparations are liable to lose their activity along with their age. As the therapeutic activity of Ergot depends mainly on the contents of the specific alkaloid, we thought it desirable to ascertain the factors responsible for its deterioration under controlled conditions.

Wokes, Elphick, Thomson, Mukerji and others have already studied the deterioration of water insoluble alkaloids of Ergot under various conditions. In order to study the rate of deterioration of water soluble alkaloids 0.1% Ergometrine in 1% tartaric acid was freshly prepared and was kept in well stoppered bottles in cool room, in room temperature and in incubator. Each sample was tested for its Ergometrine content at the interval of a month and a half. Some foreign preparations Ergometrine was similarly treated and the rate of deterioration was noted. To study the rate of deterioration of water soluble base of Ergot in sun light, a solution of Ergometrine was prepared and it was exposed to sun light in three different coloured bottles. Each sample was subjected to frequent testing for its alkaloid content. In course of a month the alkaloidal content in the samples came down from 100 mgs. to 45 mgs. (in dark blue bottle), 100 mgs. to 24 mgs. (Amber coloured bottle), 100 mgs. to 6.5 mgs. (white coloured bottle).

These observations indicate that the rate of deterioration of water soluble alkaloids not only depends on temperature but also on the nature of the container.

*This work was done in the department of Physiology, Michigan State College, East Lansing, Michigan, U.S.A.

26. Chemical Investigation of the Natural Fruit-body of the Fungus—*Polystictus Sanguineus* (L) Mey.

N. K. SEN *and* P. R. BANERJEA, Calcutta.

A chemical analysis and study of the antibacterial activity of the natural fruit-body of the fungus *P. Sanguineus* have been made. When subjected to extraction with various solvents, it gave fractions of varying antibacterial action. Water and ether extracts of the fresh fruit-body yielded a product with acid character (pH, 4.4) possessing maximum antibacterial activity against typhoid bacillus and staphylococcus aureus.

The active substance called "Polyporin"was found to be thermostable and non-volatile (Nature, 1946, 158, 295). Sodium salt of the antibiotic was prepared, which retained its activity against typhoid bacillus for a long time.

Petroleum ether extracted a mixture of hydrocarbons and some colouring matter. The chloroform extract was found to contain two pigments, one red and another yellow and the presence of flavone was detected in the yellow portion.

Further work is in progress.

27. Estimation of Quinine in Small Quantities Employing its Fluorescence as Indicator.

I. B. BOSE *and* A. BHATTACHARJI, Calcutta.

Quinine sulphate solution in dilute sulphuric acid exhibits strong fluorescence in ultra-violet light. When sulphuric acid in excess of that required for the formation of quinine sulphate $(C_{20} H_{24} N_2 O_2)_2 H_2 SO_4$ is just neutralised by sodium hydroxide solution marked decrease in the fluorescence is observed.

The possibility of employing this sudden and significant change in the fluorescence, as an indicator for the neutralisation of the sulphuric acid in the estimation of quinine by titration after extraction in a pure form from its pharmaceutical preparations, has been investigated in this paper.

Pure quimine sulphate in quantities of 10 mgs. has been estimated by the above method after extraction with chloroform in the usual way. When titrating the excess of sulphuric acid against sodium hydroxide, the ultra-violet lamp was so adjusted that the vertical beams fell on the quinine solution in the beaker. The end point was reached when the first significant change in fluorescence was observed.

Over a dozen quinine sulphate solutions in varying quantities representing from 5 to 30 mgs. of quinine were assayed by this method and the recovery was found to be almost quantitative, the deviation ranging between 0.7 to 4 per cent. In order to test how far this method is applicable for quinine solutions containing small quantities of strychnine and other ingredients (as ordinarily found in pharmaceutical preparations), assay was carried out in solutions of quinine sulphate to which strychnine in proportion of 2 to 3 per cent. of the quinine present was added it was found that strychnine if present in such small amounts, the estimation of quinine is within the the allowable errors, although the deviation in this case (5 to 9 per cent.) was slightly higher than in quinine solutions alone, which is normally to be expected.

28. A Study on the Fluorescence of Kayara Gum, Tragacanth, Acacia and their Preparations, in Ultra-Violet Light.

I. B. BOSE and J. N. MUKHERJEE, Calcutta.

The flourescence of some gums in various forms, and of their preparations when exposed to ultra-violet light from Hanovia-Muir Quartz Analytical lamp with nickel oxide filter has been studied with a view to ascertain how far this technique can be applied for this evaluation and for the detection of the nature of adulteration if any.

The three gums Karaya (*Sterculia urens*), Tragacanth, and Acaica both in solid and powdered forms showed strong fluorescence. Their aqueous mucilages and other preparations were also fluorescent though less than the original gums. The fluorescence was found to decrease when stored for very long periods, particularly genuine old museum specimens.

Soluble gums when incorporated in aqueous preparations showed less fluorescence, but when acidified a considerable increase in fluorescence was observed which, however, was reduced when made alkaline. The insoluble portions of these aqueous mucilages were strongly fluorescent if at all.

In order to test the application of this method for grading samples of gums, three samples of Karaya gums (*Sterculia urens*) found to be genuine by other tests were exposed to ultra-violet light and all of them showed bright bluish white fluorescence almost of equal intensity. Three samples of Tragacanth Powder classified as (*i*)fairly good, (*ii*) medium and (*iii*) bad, on the basis of other tests were examined for their fluorescence and were found to have fluorescence in descending order according to their quality. Some pharmaceutical preparations containing karaya gum were also examined, which showed fluorescence of varying colour and intensity as they were composed of various ingredients some of them having their own characteristic fluorescence.

Nutrition

29. Protein intake in Orissa.

K. SUBRAHMANYAM *and* S. M. BANERJI, Cuttack.

The nitrogen partition in the urine of a number of Oriyas selected at random, was done. It was found that the total nitrogen and urea nitrogen were very low and the percentage of urea nitrogen was 65% indicating that the protein intake here is much below the recommended dietary allowance. Further, estimation of uric acid and phosphate revealed that the diet is also very poor in purine compounds.

30. The nutritive value of the fat in Ground-nut milk.

H. S. R. DESIKACHAR, S. S. DE *and* V. SUBRAHMANYAN, Bangalore.

The milk prepared from groundnut contains about 3.5% fat finely dispersed in the emulsion. The nutritive value of this fat compared with the fat present in cow's milk was determined by growth experiments on rats. The milks were fed as a sole source of fat to comparable groups of rats which received a fat-free basal ration adequate for growth in all respects. Vitamin A and D were also sulplied along with the basal ration.

Since the type of carbohydrate in the basal ration influences the nutritive value of the fat, two types of basal diets were chosen. One contained predominantly lactose as the source of carbohydrate while the other contained starch. The feeding experiment lasted for two months. The average increase in weight per gram of intake of fat were 2·45 and 2·51g for groundnut milk and cow's milk respectively on the lactose diet and 2·51g and 2·64g respectively on the starch diet. The results therefore show that when the diet is otherwise adequate groundnut fat finely dispersed in the emulsion is about as nutritive as cow's milk fat.

31. High f.f. A. of Indian Edible oils (Groundnut).

K. RAMAMURTI *and* B. N. BANERJEE, Bangalore.

The f.f.A. of Indian edible oils put on the market (unrefined) is very high. Refinep oils are better in that, colour, flavour, and acidity are removed. There is no limit in the municipal or food laws to prohibit the sale of high f.f.A. edible oil. It is well known that rancid oil and fats destroy vitamin in foods and retard the digestion and absorption of the fat or oil. It is very important that scientific data on the subject be collected, experiments carried out and food laws passed to ensure the sale of only wholesome edible oils and fats. Bazar samples in Bangalore (25) of groundnut oil has acidity 1 to 7%, average 3% to 4%. Pancreatic digestion trials showed that an acidity above 1% is undesirable. It is possible to prepare such oil if fresh, healthy nuts are used and damaged, split, broken, and mouldy kernels are carefully removed. Experiments on the destruction of carotene-vitamin A with such oil in food *in vitro* and *in vivo* are in progress.

32. Vitamin A acetate for Fortification of Edible Fat.

U. P. BASU, Baranagar, Calcutta.

Edible fat is largely used as a medium for the introduction of vitamin A in the System. But as the vitamin is susceptible to oxidation, its potency on storage must be

ensured. Ethyl gallate is a satisfactory antioxidant in affording marked protection against oxidation, and vitamin A in the form of ester is again being found to be less susceptible to oxidation; accordingly it was considered that if cow's ghee, or, "vegetable ghee" be fortified with vitamin A acetate instead of the usual vitamin A concentrate which is an alcohol, the stability of the vitamin in the fortified fat would be considerably increased.

This expectation has been fully realised form a study on the respective fall in vitamin A potency in preparations of cow's ghee and hydrogenated oil made with both vitamin A concentrate and vitamin A aetate,. The incorporation of ethyl gallate (0.05%) further helps in ratarding the loss of vitamin A potency in the fortified fat. It is being concluded that in any fortification of edible fat use of a vitamin A ester would be helpful in prolonging the stability of the vitamin potency on storage.

33. Protein Hydrolysate for Oral Use.

S. K. GANGULY, Baranagar, Calcutta.

The use of amino acids by mouth is therapeutically desirable as it avoids the necessity of protein digestion and permits absorption without difficulty in patients suffering from various disorders. But as the synthetic amino acids are costly, alternative lies in preparing a mixture of acids by partial enzymatic hydrolysis of protein bodies rich in essential amino acids and other food factors, vitamins and salts.

A method has been devised by which a palatable mixture might be obtained by hydrolysing casein and ground-nut meal with papain and a polyenzyme (obtained from *Aspergillus oryzae*). The preparation is quite palatable when particularly taken with lemon or orange juice. On dry basis it contains :—

Protein (Nitrogen × 6·25)	59·87 %
Total Nitrogen	9·57 %
Amino Nitrogen	3·86 %
Ether Extractives	0·50 %
Ash	8·46 %
Carbohydrate	28·47 %

The product is rich in tryptophane, methionine, histidine, arginine, lysine, tyrosine, vitamin 'B' complex, and minerals, viz, iron, calcium and phosphorus.

34. Influence of Different Levels of Copper Intake on the Metabolism of Carbohydrate, Nitrogen, Calcium & Phosphorus.

K. SAHAI *and* N. D. KEHAR, Izatnagar.

A study of the metabolism of various nutrients conducted on kumauni bullocks at four different levels of copper intake viz. 12·31, 17·76, 20·24 & 63·28 mg per animal per day was made. Ration consisting of wheat bhusa and rape cake given to the animals, although making an adequate provision for the major nutrients, fell short with respect to copper. The total dry matter consumption and its digestibility coefficient remaining unaffected, the intake of dry matter per lb body weight gain decreased with increasing intake of copper, reaching a minimum with an intake of 7·38 mg of copper per 100 lbs live weight per day and increased again with the next higher level.

The digestibility coefficient of protein declined extremely slowly but nevertheless steadily with increasing intake of copper.

The retention of copper increased steadily with increasing ingestion of copper. The retention of Nitrogen, Calcium and Phosphorus improved with increase in the ingested copper rising to a maximum with an intake of 7·38 mg of copper per 100 lbs live weight per day and decreased again with the next higher level.

The total excretion of copper was found to closely parallel the intake, while the total excretion of N, Ca & P did not appear to be affected. By far the grater proportion of all the nutrients was excreted in the faeces.

35. Studies on the Metabolism of Copper, Nitrogen, Calcium, Phosphorus and Magnesium in Relation to Fluorine Intoxication in Cattle.

K. SAHAI *and* N. D. KEHAR, Izatnagar.

Kumauni bullocks were fed on a ration which was adequate in all major nutrients, Fluorine at the rate of 3 mg per kg live weight was administered. After about a year when the symptoms of fluorine poisoning were clearly manifested, a metabolic trial was conducted. The results showed (1) a decrease in the total dry matter consumption (2) an increase of 33 per cent in the minimum copper requirement of animals(3)a negative balance of N , Ca and copper and (4) a just barely positive balance for Mg.

36. Effect of Progressive maturity on the Cobalt Content of Some of the Indigenous Grasses and Leafy Fodders.

S. N. SINGH *and* N. D. KEHAR, Izatnagar.

The cobalt content of 16 grasses cut at four different stages of their maturity was determined. Majority of the samples were found to exhibit an uninterrupted fall in their cobalt content with the progress of maturity ; whereas the rest an increase at the scond cut to be subsequently followed by a continuous decline. The cobalt content of the three bimonthly loppings of 18 tree leaves were superior to grasses.

37. The Cobalt content of Some of the Common Animal Feeds.

S. N. SINGH *and* N. D. KEHAR, Izatnagar.

In view of the growing importance of cobalt in the nutrition of ruminants a large number of straws, grasses and concentrates were examined for their cobalt content. The amount of cobalt in as many as 60 samples of straws has been found to range between 0·01 and 0·111 part per million of the dry matter. Practically 33 per cent of these samples contained cobalt below 0·04 parts per million-its critical concentration in pastures according to the New Zealand workers. Grasses exhibited a narrower range of cobalt than the straws, all the 30 samples examined, lying within 0·028 to 0·75 parts per million. Twenty concentrates including cakes, grains and seeds and their by-products exhibited a range of 0·025 to 0·105 parts per million of cobalt. However 85 per cent of these concentrates indicate a range which corresponds to the proposed adequate range of cobalt in pastures of New Zealand and Australia.

38. Effect of Progressive maturity on the Manganese Content of Some of the Indigenous Grasses and Leafy Fodders.

P. C. SAWHNEY *and* N. D. KAHAR, Izatnagar.

The manganese content of 17 grasses cut in August, September and October at four different stages of maturity was determined. In majority of the cases continuous decrease with the progress of maturity in the manganese content was noticed. In others a fall in the second and third cuts followed by a rise in the fourth cut was observed.

The manganese content of 18 tree leaves lopped in November, January and March was also determined. They were classified into three groups, depending on the manganese content. The first group of five, exhibited maximum manganese content in the month of November, the second group of six in the month of January and the third group of seven in the month of March.

39. The Manganese Content of Some of the Common Animal Feeds.

P. C. SAWHNEY *and* N. D. KEHAR, Izatnagar.

In view of the great importance of manganese in animal nutrition, a large number of samples of grasses, straws, grains and oil cakes were examined for their manganese content. The amount of manganese in as many as 60 samples of straws has been found to range between 18·37 and 86·1 parts per million of the dry matter with the exception of paddy straw which showed as high as 772 parts per million of the dry matter. Practically 50 per cent of these samples contained manganese below 50 parts per million of the dry matter. Grasses exhibited a range between 22·23 and 212·64 parts per million

of the dry matter. Nearly 33 per cent of these samples contained manganese below 50 parts per million of the dry matter. Twentythree concentrates including oil cakes, grains and seeds and their by-products exhibited a range between 27·33 and 153·47 parts per million on dry matter basis. 66 per cent of these concentrates contain manganese below 50 p. p.m., 5 per cent show an adequate range of 50·60 p. p. m. according to Wisconsin workers and 29 per cent are high in manganese.

General Physiology

40. The problem of the structure of the vowels and the consonants in human speech.*

C. R. SANKARAN, Poona.

The paper gives a brief resume of the earlier approaches to the problem. The construction of α-phoneme theory is shown.The *toolvalue* of the α-phoneme theory indicating its *derivative* consequences is discussed. The α-phoneme theory is demonstrated to be purely a mathematical concept.

41. Climatic factors in relation to Comfort in tropics-A preliminary Report.

G. SANKARAN *and* M. N. RAO, Calcutta.

The subjective feeling of Comfort is based on the reaction of the human organism to the environment, physical as well as psychological. Climatic conditions comprise in main the physical environment. In a tropical country like ours, climatic factors assume even a greater importance. The correlation of different climatic factors with Comfort in Calcutta is reported in this paper.

Comfort Votes and climatological data were collected twice a week continuously over a period of one year. Eight climatic factors

(1) Dry Bulb Temperature
(2) Effective Temperature
(3) Dry Red Kata Rate of cooling
(4) Wet Kata Rate of cooling
(5) Relative Humidity
(6) Air Velocity
(7) Evaporative cooling
(8) Dry Blue Kata Rate of cooling

were correlated with the 3930 Votes collected on a 13 point scale of Comfort.

The Dry Bulb Temperature and the effective temperature were the two that gave the maximum correlation.

42. Haematological studies at high altitude.

C. R. DAS GUPTA, *and* C. CHANDRASEKHAR, Calcutta.

Haematological studies were carried out on adult healthy residents at Gangtok, 5,900 ft. above sea level and at Kalimpong, 3,933 ft. above sea level.

Comparing the values of Indian males and females of plains and hills.

Indian males in the hills have higher values for haemoglobin, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration than Indian males in the plains. No difference emerges in red cell count and in mean corpuscular volume between the residents in the hills and in the plains.

Just as in the case of males, Indian females in the hills have higher values for haemoglobin, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration than Indian females in the plains. Also, as in the males, there is no difference in the mean corpuscular volume between the residents in the hills and in the plain. But unlike in the males, in the red cells, the Indian females at Kalimpong have a slightly but not significantly higher values while the Indian females at Gangtok have significantly higher values than the residents in Calcutta.

---

*An investigation carried out with the generous grants from the Bombay University.

43. Synthesis of acetylcholine in the small intestine by adrenaline.

M. L. Chakravarty, Calcutta.

It has been recorded by previous workers that synthesis of acetylcholine by adrenaline takes place in some living tissues as well as in the dead. No work appears to have been done if this occurs in the gut. The subject has a great clinical significance because if synthesis takes place then the whole outlook of treating cases of haematemesis or hypermotility of the digestive tube with adrenaline has to be changed. Adrenaline came into the therapy for such malady because of its sympathomimetic action. Sympathetic being an inhibitory nerve adrenaline has been in use to inhibit the movement. It has been found in the course of experiments on the isolated small intestine of rabbit that when adrenaline was added under certain conditions, the gut showed stimulation resembling the stimulation when acetylcholine was added to the bath. The dominant inhibitory effect of adrenaline on the gut was there, nevertheless because of the formation of acetylcholine the gut showed stimulation. Hence when the gut was in contact with adrenaline, the stimulation was not abrupt nor it was so marked but when the adrenaline was washed away the stimulation was not only marked but also immediate. After a very minute dose of adrenaline the gut showed only a stimulation.

Production of acetylcholine after adrenaline gains support from the fact that stimulation was enhanced by eserine and abolished by atropine. The stimulation always took place in the fresh gut. Gut cooled for more than 48 hours in Tyrode's solution in the ice chest and a piece of gut fully nicotinised failed to show stimulation under similar conditions.

44. Urinary Proteose—A Secondary Endogenous Allergen ?

J. C. Ray, *and* Sachindra Nath Chaudhuri, Calcutta.

Oriel and Barbar detected a nitrogenous matter, which they called proteose-like substance, in the urine of allergic cases. They claimed that this substance contains the allergen to which the patient is sensitive and may be effectively utilised in the treatment by method of hyposensitization. With antigen-antibody reactions as the basis of the condition Urbach classified the allergic state as follows :-

(a) Exogenous allergy i.e., the allergen imported from outside the organism. It may be :-

- (i) primary, exerting its effect as it is.
- (ii) secondary, becoming allergen only after being altered in the system.

or (iii) Hapten or residual antigen acting with specific antibodies but not antigenic.

(b) Endogenous allergy i.e., the allergen is elaborated in the system of the organism. This may be :-

- (i) auto-endogenous, i. e. allergens manufactured by pervert tissues, they may be primary (directly from diseased tissues), secondary (from allergised tissues) or haptens (residual antigen).

or (ii) hetero-endogenous, source of allergens being bacterial metabolism in the system.

Now what position, as allergen, Oriel's p-substance occupies in this system of classification has not been yet determined. Oriel's opinion that it contains the endogenous allergen has only been empirically supported by Urbach who considers it to be a secondary endogenous allergen, but his opinion has not been scientifically proved. The present paper will discuss this problem based on experimental observations (though of preliminary nature) in this laboratory.

45. Physiological Studies on the Blood of Domestic Animals. Part 3. Lactating buffaloes.

C. V. Rao, V. N. Murty *and* N. D. Kehar, Izatnagar.

Blood samples of six buffaloes were subjected to morpological and chemical analysis at fortnightly intervals throughout their lactation period of about 9 months from the date of calving. The highest concentration of the morphological and chemical constituents, observed between the 4th and 6th week, has shown a gradual fall with lactation. During the last month of the lactation, all the blood constituents showed a steady rise.

46. Reversible nature of Changes in basal ganglia in Parkinsonism.

NAGENDRANATH DE, Calcutta.

Definite organic changes have been described in the basal ganglia as responsible for the syndrome know as Parkinsonism. It has been said that disease, degeneration or injury of the globus pallidus leads to rigidity and that of the substantia nigra to tremour. But it has been observed that (1) the course of Parkinsonism may be interrupted by a period of absolute remission by an attack of another disease supervening and that

(2) administration or otherwise intake of some drugs and chemicals produce the syndrome which lasts only as long as the drug remains in the system above a threshold level.

These indicate that whatever changes are produced in the structure and function of the basal ganglia in these cases are reversible.

47. Mammary-Pharyngeal reflex.

S. N. MATHUR, Lucknow.

At a previous session of this section of the Science Congress I gave my observations regarding a gastro-skin reflex. It was shown that the body possesses a mechanism for conserving water for emergency purposes. This mechanism inhibits the perspiratory activity whenever stores of water reach a certain minimum even though the skin temperature may be unpleasantly high. Under such conditions, which prevail during summer, a reflex starts from the stomach after taking water which restarts sweating.

Present observations are on a related reflex which may be termed Mammary-Pharyngeal reflex. This is only present in lactating women. It starts from the nipple of the mammary gland as soon as the child starts sucking. It has been observed that as soon as the baby puts in the nipple in the mouth the mother feels dryness in her mouth and feels thirsty. This is felt even though the mother may not have felt thirst at all immediately before sucking. This is obviously a nature's mechanism to restore back water going to be lost through milk, in advance.

Miscellaneous

48. Influence of Proteolytic Enzymes upon the Ionic Adsorption of Diphtheria Antibodies.

M. M. BISWAS, Calcutta.

Conducto-metric titrations of diphthoria antitoxic serum have been carried out with N/1 sulphuric acid and N/1 sodium hydroxide. The antitoxin have also been subjected to a process of proteolytic digestion at the isoelectric point and titration curves of the digestion mixture drawn at start and after 48 hours. Corresponding pH values have also been recorded. The titration curves of the antitoxins under the various conditions definitely prove that pure antitoxins possess a superior adsorbablility of H′ and other ions and the enzyme digestion process has got a marked influence on the nature of the antitoxins.

49. Microbiology of Figs during Drying.

C. P NATARAJAN, C. N. CHARI *and* E. M. MRAK, California.

In California figs are ordinarily harvested from the ground when about two-thirds dry. Drying is completed on trays exposed to the sun. During this period yeast and mold population commonly increase in the fig to such an extent that spoilage occurs. This is particularly true in cool and foggy weather. Tests were conducted to determine the effect of counter current dehydration on the yeast population in figs. Maximum drying temperatures of 130 and 140 were chosen because in this range the maximum rate of drying is obtained without causing heat damage and subsequent discoloration of the fruit. Figs dehydrated at a maximum temperature of 130 showed a slight increase in yeast count during the first 2 hours then a gradual drop in the next 8 hours when they

were considered adequately dried. The temperature of the interior of the fruit as determined by thermocouple measurements reached that of the dry bulb of the dehydrater in 3 hours. Fruit dehydrated at a maximum temperature of 140 also showed a slight increase in yeast count during the first 2 hours of drying. This was followed by a gradual decline during the next 3 hours and a very sharp decline during the last 3 hours. The time required for the interior of the fig to reach dry bulb temperature was about 5 hours. In neither case were all yeasts killed. The average count of yeasts per fig for those dried at 130 was 10^7 at first, and 10^5 when dry after 10 hours. Those dehydrated at 140 dropped to 10^3 in 8 hours when the fruit was considered dry. Counts made on figs dried in the s un showed considerable increases. In view of this dehydration is recommended as a means of reducing yeast count and spoilage in figs.

50. The Cutler Test in Kala-azar.

N. K. CHAKRAVARTY *and* P. C. SEN GUPTA, Calcutta.

The test originally introduced for the diagnosis of Addison's disease was applied to a series of 53 cases of kala-azar and 12 controls. Besides the urinary chloride in the last four hours of the test period, the plasma chloride before and after the salt deprivation was also estimated, The maximum urinary chloride concentration in the control group of cases was 300 mgm per cent (as NaCl), the mean and standrad deviation being $153 \cdot 0 \pm 85 \cdot 2$ mgm. per cent. In the kala-azar group of cases, 16 showed an excretion above 300 mgm per cent and the mean and standard deviation of the whole group was $262 \cdot 7 \pm 158 \cdot 8$ mgm per cent. Thus compared with the control group, 30·2 per cent cases of kala-azar gave a positive reaction. Also the percentage of positive reactions was 25 for early cases, 30 for moderately advanced cases and 33·3 per cent for the well developed cases of kala-azar, If we consider the results of the test in this series of 53 cases of kala-azar according to the standards laid down by Cutler, positive results were obtained in 17 per cent (9 cases), doubtful results in 39·6 per cent (21 cases), and negative results in 43·4 per cent (23 cases). It is probably more accurate to compare our results with the results obtained in our control.

The test was repeated in three patients with the administration of of desoxycorticosterone acetate (DOCA) during the test procedure. All the patients who had given a positive reaction with the Cutler test responded to DOCA by lowered chloride excretion. The chloride concentration was sufficiently reduced in two cases to indicate a negative reaction and in the other it still persisted as positive.

The high proportion of positive reactions (33·3%) in the well-developed cases of kala-azar indicates that there is an involvement of the suprarenal cortex frequently in the course of the disease. The pigmentation of kala-azar, that in advanced cases is somewhat similar to that seen in Addison's dissase, can thus be explained on the basis of adrenal hypofunction. Low blood pressure, lack of muscular tone, emaciation and asthenia may possibly be due to the adrenocortical insufficiency.

51. Creatinuria Index in Lathyrism.

M. N. RUDRA, Darbhanga.

Creatinuria Index has been determined in six lathyrism patients of 15 days to 3 months duration. The values obtained varied from 1·03 to 1·24.

52. A Case of 'dropsy' in a fresh water fish, *Ophicephalus striatus* Bl.

M. RAHIMULLA, Hyderabad-Deccan.

A female fish was found in the month of July 1946 in the Hosainsagar reservoir, floating upsidedown, in a living condition. The abdomen was full of fluid ; the stomach and intestine were empty showing that the fish had stopped feeding. The liver was of a yellowish colour and in an unhealthy condition. The gonads were shrivelled and a few unhealthy eggs were present, although it was the breeding season. The fish was not healthy as shown by the ruffled condition of the scale on the abdomen and the sides.

The author has communicated this paper to this section only besause the medical authorities assembled there will be able to throw some light on this disease. Is it in any way similar to the one found in human beings ?

53. Vitamin C and Sleep.

S. N. Mathur, Lucknow

It has been observed that Vitamin C is a potent factor in causing sleeplessness by its absence and bringing about sleep when given in such conditions. These conclusions are based on observations made on human beings and have been so convincing that it was thought desirable to communicate. First observation was made on a neighbour who had not slept for a fortnight, as he told me. From his dietetic history it was concluded that there was complete lack of Vitamin C from his diet extending to over several months and lately there was almost complete lack of all other vitamins also. For over one month he was living on sugo bread and meat soup only. He had several dozen prescription in his possession exhausting practically all the sudorific and hypnotic drugs taken one after the other. He had reached a stage when no drug could induce sleep. On my advice he took two tumblerful of carrot juice, He reported next day that soon after taking the juice he slept like a log and had not known a sounder sleep in his life. Similar report was given by a doctor friend of mine whom I gave about 100 mg. of ascarbic acid, Since then observations have been extended our self, my family, and relatives and friends. Latest observation is on an infant 5 months old who when ever he misses his does of vitamin C, either as ascorbic acid or fruit juice sleeps badly. Sleep is speedily brought about by giving him a little extra vitamin C.

As regard the mode of action no explanation can be offered at this stage. Two theories can however be suggested. One, that, as in scorbutic condition, it prevents excessive diffusions of blood which might cause sleeplessness, the second, that it is some way, as esserin for example, potentiates the action of parasympathetic part of nervous system either directly or indirectly

PROCEEDINGS

OF THE

THIRTY-FIFTH

INDIAN SCIENCE CONGRESS

PATNA, 1948

PART IV

CONTENTS

PROCEEDINGS

OF THE

THIRTY-FIFTH INDIAN SCIENCE CONGRESS

PATNA, 1948

PART IV.

DISCUSSIONS

PLANNING FOR NATIONAL HEALTH SURVEYS AND A CENTRAL INSTITUTE FOR THE ASSESSMENT OF NATIONAL HEALTH

(Sections of Statistics, Medical and Veterinary Sciences and Physiology)

SRI S. N. ROY, President, Statistics Section, presided.

DR. K. C. K. E. RAJA, New Delhi, opened the discussion.

The need for a continuous study of national health problems will be universally accepted. It is, at the same time, necessary to consider the conditions required for such continuous study and the nature and extent of the contribution which the proposed Institute of National Health will be able to make in this connection. Information regarding the socio-economic conditions of the population group under investigation is essential for the study of health problems and such information can be collected by staff trained for this work in the field. On the other hand the collection of information relating to specific problems will require the employment of persons with expert technical knowledge. For instance, a tuberculosis survey will require the application of skin tests such as Mantoux test on the group under study as well as mass radiography and examination by doctors with special experience of the disease. Somewhat similar conditions will have to be fulfilled when investigations into other forms of disease are undertaken. It is not possible to have on the establishment of the Institute of National Health the many types of expert staff required for the study of the wide variety of health and sickness conditions which it may be called upon to undertake. In my view the data required for a continuous study of individual and community health problems must flow as a by-product of sound health administration. The establishment of such administration envisages the creation and employment of the necessary expert staff in every field of health and, without adequate numbers of such experts, investigations on a reasonably wide scale can hardly be undertaken. Take for instance, tuberculosis. It is estimated that the total number of doctors who can be considered experts in this subject is about 70 or 80 in any case below 100, and these are all so actively engaged in the management of tuberculosis institutions and in the treatment outside such institutions, of the innumerable patients demanding their care that, with rare exceptions, they have had little time to devote to the study of the epidemiological and other community aspects of the tuberculosis problem. It is not intended to undervalue the importance

or need for such study but the facts are there and they must be taken into account in attempting to achieve a correct estimate of the situation. So long as the need for immediate medical relief for tuberculosis patients is far greater than existing provision for it the relatively few experts in this field are bound to seek the more lucrative avenue of ministration to individual patients than the path of attempting to unravel the causative factors associated with tuberculosis as a community problem.

Another instance may also be referred to. Reasonably correct vital statistics are essential for the study of most health problems. Apart from the question of preventing the large percentage of omissions in the registration of such statistics which now occurs and which is relatively easy to tackle, the problem of ensuring a reasonable measure of accuracy for the recorded causes of death can hardly be solved without medical certifications, which can develop on a satisfactory basis when the country's health services expand considerably.

Reference may be made to another matter also. The purpose of all investigations into health problems is to facilitate the enforcement of the steps required to remedy the defects discovered and to promote the provision of the necessary measures for treatment and prevention. Taking tuberculosis again as an instance, such investigations as have already been carried out point to the prevalence of the disease on a scale which justifies its being labelled as Public Enemy No. II in the list of diseases which sap the vitality of the nation and general experience shows that, in all areas, the number of persons requiring urgent medical attention on account of this disease is many times more than existing provision for their reception and care. A detailed investigation in individual places will no doubt bring out more clearly the nature and extent of tuberculosis infection in those areas but, without a simultaneous advance in the provision of remedial and preventive measures, the situation from the point of view of the community is hardly improved. From this standpoint also the establishment of a national health service should be considered as more important than mere investigation into existing health conditions. I have already pointed out that, without an adequate number of doctors with special training in the subject, the undertaking of large scale investigations can hardly be attempted.

Lastly it should be emphasised that the functioning of national health service on sound lines will itself promote study into the health problems of the country because no progress in the control of disease or promotion of positive health is possible without epidemiological and other studies intended to provide the basic knowledge on which all administrative measures will have to be founded.

I must repeat that it is not intended to minimise the importance of the study of national health problems. The purpose in view is only to point out the limitations under which the proposed Institute of National Health will have to function and to emphasise that the continuous study of such problems can be undertaken successfully only with an adequately developed national health service. It is at the same time recognised that such an institute, if established, can even under existing conditions promote investigations in many directions. It can also serve the dual purpose of helping in the designing of sample surveys and of coordinating studies in the field of health in different parts of the country. The Institute will derive advantage by working in collaboration with other agencies concerned with the promotion of medical research, for instance, the Indian Research Fund Association.

DR. R. B. LAL, Calcutta.

A survey can be fruitful, only when it has been carefully planned. Besides a well planned survey will give the best value for the money, time and energy spent on it. Planning will embrace both methods and organisation. The details, in either case, will depend upon the objects, and scope of the survey and upon the means available. These must be clearly defined and understood before planning is undertaken.

Objects may vary according to circumstances. However, it may be stated at the outset, that apart from its scientific value and development of technique, an elaborate survey carried out at public expense, will be justifiable only when it is intended to shape public policy. If this intention is fulfilled, a well planned survey will not only repay the expenditure incurred upon it many times ever, through saving in time and money, but it will lay down a solid foundation for ordered progress of the community.

National surveys may be conducted at various levels. They may constitute integrated experience of surveys of small communities, such as villages or factories and of intermediate administrative units of varied sizes or they may be carried out at the national level only. Their objectives and scope will vary accordingly and so also the means required to carry them out. In the former case local conditions at varous levels will be known and the differences between corresponding units as well as the reasons for these differences will be brought out while in the latter case the individual pattern of various sized units will not be available. This point should be settled before planning is commenced.

Another factor which will have to be taken into consideration and which will greatly influence the scope and means for carrying out the surveys is the nature and the amount of available knowledge, the form in which it is available and the case with which it can be utilized in relation to the objects of the survey as also the degree of confidence which can be placed in the data. Communities vary a great deal in this respect and planning will also differ accordingly.

The present discussion is limited to health surveys. Our experience with health surveys has led us to the conclusion that factors which presumably affect health, directly or indirectly, embrace such a wide field that practically the surveys become all aspect community surveys. There are hardly any boundaries which may partition off health surveys from surveys in the economic, social, physical, biological and other fields. A health survey must necessarily encroach upon these field just as surveys conducted in these other spheres will be incomplete without reviewing the health conditions of the community. Since surveys, as I have said, lay the foundations for ordered progress, they are equally important and necessary for all fields of human activities. Under the circumstances, would it not be logical to think and plan in terms of integrated surveys rather than separate surveys in various field. That the integrated surveys would be economical in time, money and personnel, can be easily seen but this is by no means the most important reason in support of them. It is essential to carry out integrated surveys, if the interactions of various factors constituting the society in its particular environmental set up both geographical and historical—have to be worked out and the most appropriate means to intelligently interfere in the course of events for the benefit of man, have to be discovered. Besides, integrated surveys will be essentially sound because they would be the fruits of combined labour to experts in differents fields. This is not all. There is the greatest need for these experts to unlearn the narrow-view-point, which their exclusive technical education and watertight departmental work and practice have taught them, if community welfare is to be the centre of interest and if the confusion between means and end is to be avoided. Through integrated surveys and through logical interpretation of data carried out jointly they will learn how best to make contribution of their special knowledge for the achievement of a single objective—welfare of the community. I should, therefore, plead for the establishment of a General Central Institute for Assessment of Community Welfare. Such an institution will constitute the *nerve centre* from which welfare scheme will emanate according to local priorities, at which various activities of good Government will be co-ordinated and correlated at different administrative levels and at which the rate of progress will be measured. The Institute will determine the nature and size of samples of populations to be surveyed, will work out survey plans for well defined objectives, will train personnel and supervise and assistant field staff, will provide the necessary facilities for work, will analyse and interpret data and prepare general and special reports for scientific and

governmental purposes and produce literature for educating the people in regard to their condition and in regard to the lines along which improvement can take place.

As regards General Health surveys one may refer to two of the surveys, that have been recently carried out in this country—one at the national level by Bhor Committee and the other, a local one, by us in a small area of 33 square miles constituting Singur Health Centre, in West Bengal.

Broadly speaking the first object of both the surveys, is the same, namely, to draw a picture of the state of public health of the respective units under consideration. While in the former survey reference has occasionally been made to the factors concerned in bringing about the present state of health, in the latter survey, this aim has been constantly kept in view and elucidation or evaluation of the factors has been inferred from observations so far as the data would permit. An endeavour has been made to crystallize problems on the basis of quantitative data. The main difference in the two causes, however, is in regard to scope and methods. In the national survey carried out by the Bhore Committee, the authors have largely depended for their data on available reports and routine statistics and on personal impressions and opinions of themselves and of the witnesses examined by them, while the Singur survey is an objective assessment of quantitative data, regarding community structure in a wider sphere, collected on a planned basis. According to this method a national survey would be carried out by integrating the results of a series of appropriate surveys in selected localities throughout the country for different levels of administrative units. The statistical considerations and the actual methods adopted in planning the Singur survey will be found in the Preliminary Report to which a reference may be made. In conclusion certain recommendations have been made. These include suggested actions and isolated problems requiring further investigation.

Time and means involved in such a survey if carried out on national scale may perhaps be considered prohibitive by some. Actually in addition to the facilities provided by the Institute, the cost of field work in connection with the Singur survey came to about -|4|- per head of population spread over a period of 7 months. It is difficult to estimate how much amount will have to be added to make it an integrated survey comprising all fields. In any case, it will be a huge amount. Besides, personnel will have to be trained. These difficulties are real but it must be remembered that Singur Survey is the first of its kind and if a Centre for planning of national surveys is established, ways and means could be found to reduce the expenditure to manageable proportions. We believe that valuable integrated objective surveys on which policy may be based can be carried out within a reasonable time in representative areas of different provinces which may be selected on the statistical information at present available. It is also believed that a scientific approach to the refashioning of the Government's machinery will lead to the fullest utilisation of our traditional human material resources and consequently to a rapid development of the country which will make it prosperous in peace and strong in war. Below is given a skeleton proposal for a 'Pilot Experiment' in such survey work.

Proposal for a 'Pilot Experiment' in the Reorganisation of National Welfare.

I. Object:

Progressive advancement of health, wealth, culture and happiness of the whole people according to their genius.

II. Principles:

(1) The object can be realised more quickly, with greater certainty and on a more permanent basis by the application of the "Scientific method" not only to the solution of technical problems which may arise from time to time but also to the social, economic and service organisation, then by Lacser-faire of the method of hit and miss.

(2) Welfare is indivisible. There should be complete integration of all state functions both for purposes of investigation and planning and for service (organised community endeavour). Co-ordination is not enough, it may not be always possible. (For a diagramatic representations of the evolution of plan, see Science & Culture Vol. XI. P.p. 489500, 1945-46).

(3) A normal community like a normal man has a natural urge for better health, greater wealth, more culture and a greater measure of happiness. It should therefore, be given the fullest opportunities for self-expression, once it has attained an organised entity through discipline, co-operation and education on the basis of objective study. This is the plea for enlightened democracy. If the urge for self-improvement is not manifest or it is weak or perverse, the causes should be investigated and appropriate remedy should be applied. Thus a dormant urge may be stimulated into activity through the provision of facilities, which are beyond the capacity of the community unit under consideration, so as to remove its sense of frustration or through the discovery and encouragement of right leadership. A subdued or submerged urge may be revitalized by dissemination of specific knowledge or by removing or shifting the yoke of tradition in a suitable manner. Healthy competition may act as a tonic in other instances. A morbid urge will need appropriate treatment. The point is that treatment to be successful must follow and not precede diagnosis. Reforms may be successfully forced down according to a preconceived plans up to a degree but they can not be progressive, at any rate contrary to the popular notion, this method will, in the long run, prove expensive and uneconomical because it wastes much, official energy and leaves still more energy (of the common man) untapped.

(4) A man or an animal furnishes an example of a perfect organisation. It consists of individual cells, tissues and organs which are aggregated in such a way that each similar unit functions independently in its own limited sphere but at the same time it bears an organic relationship with the next higher unit. At each stage of organisation the higher unit acquires identity of its own and develop certain properties and functions which are peculiar to itself and are in addition to these contributed by the individual constitutent units. However, the expanding units work in uniform. The moment there is disharmony in their mutual relationship, the organisation suffers illness or disorder or malignant growth appears. A nation may ideally conform to such an organisation in respect of individual citizen, villages or factories, tehsils sub-divisions, districts and provinces. It must necessarily be a centripetal evolution decentralisation of functions and full recognition of rights and mutual responsibilities of the lower and the higher units in other words maximum autonomy consistent with efficiency should be retained by the lower units, at each level. Functionally such an organisation will work both centripetally and centrifugally, the circle must necessarily be completed to act as an organisation. Analogy ends therefore unlike the involuntary development of an animal, the national organisation has to be worked out by conscious effort. Anatomical and functional units have to be created on rational basis and their mutual relationships have to be determined. For this, detailed knowledge of man, society and environment has to be acquired.

III. Scheme:

The principles enunciated above give a lead or a direction along which national organisation should proceed. Accordingly a working scheme is presented.

1. *The Units of Description*: 'Family' is the smallest unit in which group phenomenon manifests itself and because of its natural, cultural and economic unity, it resembles the organisational characteristics of individual physiology more closely than any other units. Hence 'family' must be taken as the primary unit, for most purposes, in community organisation though certain individual characteristics cannot be ignored. The village is undoubtedly the next higher unit. How the villages may be grouped together into circles is a matter for consideration. The basis of grouping may vary according to local circumstances but naturally the factor or factors concerned

must intimately in 'circle community effort' would largely weigh in each case and these can only be determined after village surveys have been made. The same applies to the formation of still higher units, but it is obvious that the present political boundaries may have to be modified.

2. Integrated survey of man, society and environment of each unit should be carried out. This may be based as samples, which should be scientifically worked out. The survey should present a comprehensive factual and so far as possible quantitative and should have description of the various units from all aspects. It should discuss the operation of principle factors and their interaction. It should also crystalise and cleanly state the main problems (including these requiring further investigation) and list them according to priorities. It should strike, so to say, a balance sheet of assets and liabilities of the unit in all spheres. The "General Health Survey of Singur Health Centre" may be taken as a model for purposes of technique and organisation, but as regards contents, considerable changes will be required and they will vary according to the unit under consideration. In conducting the village surveys active participation of the more advanced villagers should be encouraged as is being done at Domjure.

3. *Education of the People*: The main results of the survey and the list of priorities should be embodied in attractive, illustrated pamphlets written in simple popular language so as to appeal to the people for whom they are meant. They should be presented from the view point of the peasant, worker, artisan, trader, etc. and not from the official or technical view point. The people should be thoroughly educated by means of poster and talks illustrated with lantern slides and cinema shows, if possible. They should be encouraged to discuss the village plans amongst themselves and with Govt. Officers who may be specially employed for the purpose.

4. *People's Council* should be created at various unit levels. Suitable devices should be employed to ensure that the councils are as representative and as enlightened as possible. The priorities should be finally selected by them. On the basis of the priorities so selected, short and long plans programmes should be drawn up for different unit level. These should be reviewed centrifugally and so modified that the plans and programmes for the lower units should fit into the general plan and programme of the unit next above.

5. *Organisation*:

(*a*) *Village Co-operation*: The village work should be organised through a multi-purposes co-operative society of which the poly-technical agents (see below) should act as Secretaries. The ultimate object of the village co-operative is to enlist every family as a member and to organise agriculture, recreation, defence, industry, trade, health and welfare activities through it. When this objective has sufficiently advanced, the society may contribute towards the part-payment of the salaries of the polytechnical agents and ultimately become responsible for payment of their full salaries. The societies should be given all encouragement in the form of technical services, advice, supervision, supply of essential materials at control rate, grants in aid for specific purposes etc. It is assumed that the co-operative socity, the village council (*panchayate*) will have sufficient common membership to ensure co-operation.

(*b*) *The Staff*:

(*i*) *Village Unit.* Polytechnical agents—a man and a woman should be appointed in each village (or part of village, if it too large or group of villages if they too small—roughly one pair for 2 to 3 populations). They should be recruited from amongst the intelligent section of the rural population who have shown initiative, enthusiasm during the survey. They should undergo a short course of training concerning all departments. Their duties and responsibilities should be clearly stated (see philosophy of Public

Health) and they should maintain proper records which should be regularly submitted to the Primary Poly-technical Board.

(*ii*) *Circle or Tehsil Unit*: Poly-technical Boards will be instituted according to the need of the unit. They will consist of representatives of different departments including general administration, police, etc. Suitable institution, dispensaries will be established according to the needs (priority) of the community on such scale as finances permit. They will progressively expand according to the needs and financial improvement.

(*iii*) Such poly-technical Boards will be developed at District and Provincial levels and will be supported by corresponding Institutions according to priorities. They will serve, support and supervise the work of the corresponding Poly-technical Boards attached to the smaller constituent units and solve the more difficult problems as they arise from time to time.

The Universities on the other hand will carry out academic researches (pure Science) and will also help to solve problems arising in the field which require deeper and a more fundamental investigations or have a long-term significance.

It should be composed of representatives of specialities most needed for implementing plans and programmes as stated in para. 4 above. The members of the Board will have joint responsibilities for service to the unit and its constitutent villages. They will assist the council in solution of all local problems. In case they present difficulties which are beyond their capacity, they will be referred to similar Poly-technical Board attached to the next higher unit. Boards membership will include general administration and police. It will elect its own President and Secretary without reference to any particular speciality.

IV. The Proposal:

The scheme suggested above is revolutionary, not so much in ideas as in its administrative set up. To-day the administration proceeds from the top and it works downwards through a machinery of official services whose tradition is to carry out orders, follow the procedure, satisfy the superiors and boss over the people. The organisation now suggested goes the otherway round. It begins with a systematic integrated observation of things and events. The would-be beneficiaries are shown how they stand, it is they who choose what they want and take the responsibility for it. The paid technical services are there to meet their needs-routine and special—to man the institutions for the required purpose and to co-ordinate activities of the constituent units with those of the ones next above. They owe their loyalty primarily to the community they serve and to whom offer their technical skill to the best of their abilities. This applies to all unit levels. The non-technical or administrative services carry out the duties of the "town clerk". In the peripheral unit-the village, the two types of services are combined into one agency—the polytechnical agents, a man and woman.

Is this set up practicable? Will it work? Will it achieve the objects more quickly, more economically and more progressively? The only way to answer the questions is to try and see it work as a pilot scheme. I have purposely avoided the word experiment because a proper social experiment will have to satisfy certain fundamental requirements such for instance as the provision of a control. This will be expensive and very difficult to carry out. Therefore what is proposed here is an investigation or exploration rather than an experiment but for short we may call it a Pilot Experiment.

The 'Pilot Experiment'.

This will be conducted in three stages, namely:—

Stage I.—The Preparatory Investigations:

An experienced officer, conversant with scientific surveys, will be deputed for six months to study the essential relevant information which is already available in various

departments of the Provincial Govt. (and elsewhere) and their plans for future development. Incidentally he will be on the look out for suitable personnel, available in the province and outside, for the scientific survey and for subsequent work. He will see the institutions and meet the officers who may be help later. He will particularly note the places where various grades of staff may receive proper training.

After completing this study he will draw up a detailed scheme of the survey and select the area where the 'experiment' will be carried out.

The area selected should represent, as far as possible, the average conditions in the province in regard to the essential circumstances. The most suitable size would be a District where service and institutions of different types could be developed on a fair scale, on sound economic basis. Such an unit would furnish a reasonably large sphere of varied activities. However, there are disadvantages in taking such a large area initially. It may prove unweildy when the development or evolution of plans and methods will require considerable personal attention of the 'experimenters'. Lack of trained staff will also be a limiting factor and the period of 'experiment' will have to be rather long. For these practical reasons a smaller area such as a Tehsil will be more suitable.

Stage II.—The Survey:

A Board of Officers representing the progressive elements of all the departments (a tentative list of specialities to be represented is attached) will be constituted. These officers will be seconded to the 'experiment' as whole time workers. The Board will review the scheme of the survey in detail and make suitable modifications. It will appoint and train the staff. It will elect its own president and secretary and will draw up its rules of procedure.

The members of the Board will be jointly responsible for carrying out the survey and will write a joint report, but intensive studies on special problems based on the data collected in the course of the survey or on problems arising from the, may be undertaken by individual members or groups of members with the approval of the Board. Every effort will be made to train as much of the staff for the third stage of the 'experiment' as possible and also to make contact with the people who are likely to take leading part in the evolution of the scheme later on. With proper management the survey should be completed in one year and nine months under proper circumstances—one year for the field work, six months for analysis and three months for writing up the report.

Stage III.—The Evolution of Services, Institutions and Peoples Councils and the working of the new set up

During the stage of following processes will be carried out (*a*) Educating of the people and the determination of priorities by them at different unit levels. (*b*) Development of procedures and their frequent review to affect modifications as and when necessary. The greatest possible emphasis will be laid on elacticity and adaptability in procedures. It may take one year for the procedures of the 'Experiment' to become sufficient stabilised for routine working to proceed. (*c*) Once this has occurred, it shall be allowed to go on for two years. (*e*) At the end of that period fresh survey shall be conducted and a comparison still be made to note the results of the 'experiment'. In making this comparison due regard shall be paid to the changes brought about in community outlook and its organisational capacity which are the essential ingredients for the progressive development of the society.

DR. N. S. R. SASTRY, Bombay.

The success of any survey depends upon the proper design, clear enunciation of all factors that have to be investigated, preparing proper schedules and the training of investigators. He further explained which type of sampling might be useful for conducting such health surveys.

DR. P. G. CHOWDHURY, Calcutta.

Dr. Chowdhury referred to the organisation of statistical work in Public Health Offices of different provinces in India. He then explained certain techniques such as construction of variation chart for the current mortality analysis etc. which would be useful for analysing the data obtained from health surveys.

MR. K. C. BASAK, Calcutta.

Mr. Basak stressed the point that integrated surveys would be more useful than separate surveys.

DR. K. MITRA, New Delhi.

At the outset I must express my gratitude to the Chairman for kindly permitting me, a member of the audience, to make a few comments on this subject of very great national importance. In describing the poor state of health of the population in India, Mr. Basak had used the term C3. I wish that reasonably precise methods for discriminating C3 from C, grade of health in population groups were known to us. It would be no exaggeration to say that in the present state of our knowledge it is an extremely difficult problem for field workers to grade the state of health even in broad groups ot A, B and C with any reasonable degree of precision. As long as a man (or a woman) is not ill he is beyond the purview of the regional units of medical and health departments. Vast multitude of people existing on the borderland of health are presumed to be 'well', and probably as well as he is ever likely to be. The reason for this mental attitude is not far to seek. Methods for assessing the grades of health, either in the ascending or descending order have yet to be evolved.

Dr. Lal in his remarks has referred to his elaborate health survey report of Singur. I must confess that I did not have the opportunity to go through this learned document, but I had an opportunity to glance through a few pages when it was being passed round a few moments ago. The schedule of enquiry as also the tabular statements in the report show, that those individuals who were not clinically ill during the period of survey have been designated as "well" and classified under two broad groups depending on whether they were 'sick' or 'not sick' during the year. I do hope that the research programme of the healthy survey unit as envisaged by Dr. Lal would include research activities on the assessment of health (Synonymous with nutrition). It is time that indexes for assessment of health as a position attribute of individuals surveyed, be evolved and standradized for making comparable studies.

Mr. Gopal Shastri has spoken on the merits, or should I say, on the demerits of detailed investigations. Dr. Lal would, I hope, deal with this point in his reply. I can not however help commenting that reasonably detailed investigations are necessary in view of the fact that we are so short of information. Everybody knows how efforts may be wasted in carrying out questionnaire method of surveys and how the inferences drawn from the collection, reduction and tabulation of data may be misleading.

Mr. Shastri seemed to doubt the statement made in a report (unnamed by him) that a group of industrial workers in India had consumed 3,500 calories daily during the period of survey. In my modest experience of diet survey amongst groups of industrial workers, quite a number of persons were found to consume 3,500 calories daily. I am not referring to isolated instances. The method of survey followed by me was the weighment of each item of raw foods before they were cooked for a period of a week

or ten days in all the families visited. The calorine values were later calculated with the help of accepted tables.

I would conclude by referring to the rather Ticklish subject of "random sampling of population or family groups" mentioned by some of the previous speakers. I have heard of the criticisim levelled against dietary survey workers that could not sample fairly comparable number of families in different income groups. I do not pretend to be a statistician but in sampling of families in any village, town, or taluqa one cannot avoid discovering at the end of the investigations that he has inspite of his best intentions, included a very large number of families which can probably be counted in hundreds, in the lowest income group but by tens only, in the upper income groups. Such state of affairs can be remedied to a great extent if and when income of individual families could be ascertained without creating a feeling of distrust and the family units willing to co-operate in such enquries.

DR. M. L. CHAKRABARTY, Calcutta.

It has to be realised that in promoting health the food must be complete. Our food is mostly incomplete and unbalanced. Attempts must be made in all possible ways for making the food complete and physiologically balanced. Facts can not be denied although so many explanations are there, that there is a general decay in the standard of national health in India and I hold deficiency in food to be primarily responsible. This deficiency can not perhaps simply be made up from bottles as is the fashion and futile attempts are now going on in this direction through the supply of vitamin tablets. I suggest that not only a thorough analysis of common food material with regard to its Food value, Protein, fat, carbohydrate, salt—Ca, Na, K, Iron, Iodine etc, vitamin-contents, disegtiblity co-efficient and protein potency etc. should be taken up, but I also suggest at the same time an analysis of the soil on which their growth depends. It is already an established fact that the quality of the milk depends on the food the mother is on, whether in human female or in cattle. There is every reason to believe that the quality of food also depends on the quality of the soil. I think it is necessary simultaneously to direct a portion of the energy devoted for National Health Planning to the investigation of the food stuff along with the soil and to watch the influence of its contents in the growth of the food material. Every endeavour must be made to enrich the soil condition upon which depends the healthy growth of food, which again is perhaps the most important factor in building and fortifying the health of the community.

Dr. B. C. Guha and others participated in the discussion and they all felt that "Planning of National Health Surveys" was a great necessity.

SYMPOSIUM ON "PHYSIOLOGICAL BASIS OF HEALTH AND LONGIVITY"

(Sections of Physiology and Medical & Veterinary Sciences)

PROF. N. M. BASU, Calcutta, presided.

K. MITRA, New Delhi, opened the discussion.

Until this morning I had no knowledge that I shall be asked to open the discussion on this subject, consequently I was not prepared for it. But I very readily accepted the invitation from the chair for reasons more than one. I shall, however, confine my remarsk to the assessment of the state of health in its positive aspect in human subjects. The terms 'state of health', 'state of nutrition' or 'state of physical fitness' apparently sound synonymous and even laymen are presumed to know what such terms ordinarily imply, but paradoxically enough the medical profession find it extremely difficult to measure such states with any reasonable degree of precision or define the physiological basis of each of them or the whole group.

Nutrition workers in India found that the appraisal of health by any fairly rapid device, a formidable problem during the aftermath of the severe Bengal famine of 1943 and also during the post war food shortage conditions. They were often asked by the administrators to indicate which administration unit (thana, taluqa, district or even province) needed bigger supply of essential foods or bigger size of ration purely from the point of view of the state of nutrition (or health) of its population. The answer in any case was not as simple as it looked to the administrators responsible for the procurement and distribution of food. The concept of health as a measurable quantum is still nebulous. No clear cut index or yardstick to measure the state of well being (synonymous with nutrition) has so far evolved from past experiences. The data pertaining to the clinical, somatomertic and biochemical findings collected in the prisons of war camps during the second World War and published during the recent years are far from complete owing to the inherent limitations in such investigations. In consideration of the fact that a very large percentage of population in India exist on the borderland of health, it is extremely important that efforts should be made by physiologists and public health experts to evolve or suggest at an early date, some practicable and comparable indexes for the assessment of health.

I would briefly state the various indexes that have been and are still in use as basis for assessment of the state of health. These indexes can be grouped under the broad headings of biochemical, haematological, clinical and somatometric.

Of the biochemical tests, measurement of the urinary excretion of any particular nutrient or nutrients has been very widely used, for appraisal of nutritional state in groups of population. But the urinary excretion level can be estimated on a limited number of individuals and does not often reveal a complete picture of the state of health or nutrition. The other seemingly accurate biochemical index is the estimation of any of the nutrients (protein or vitamins) in blood. About eight months ago I had an opportunity to study the various biochemical estimations carried out by the Nutrition Survey Groups of the Allied Control Commission in different parts of Germany. Estimation of plasma protein by relative density gradient method using a mixture of light paraffin and bromobenzene seemed to be practicable in large scale investigations. But the point at issue is whether this test as a measure of health or nutrition is useful in detecting small but appreciable deviation from the state of good health. If plasma protein measures 5,75|100 ml. in nine cases out of ten individuals are likely to be in such a poor state of nutrition that his condition could easily be diagnosed by the naked eye, instead of having to take recourse to biochemical methods. Estimation of vitamins A and B or B complex concentration in the blood does not help in arriving at a reasonably accurate estimate of the state of health except in a few cases when extreme degree of malnutrition or serious deficiency of any of the vitamins are present.

Of the various haematological indexes consisting of haemoglobin concentration, total and differential cellular counts, mean corpuscular volume, haematocrit, colour index etc. the first named one is of partial help in low state of health. Appreciable deviations of other indexes is often associated with definite clinical conditions. Though low haemoglobin level is an indication of poor state of health within certain limitations, the converse is not always true. Moreover results of haemoglobinometry carried out without standardized methods, loses much of its value.

Clinically we know very little about health in its positive aspect. The medical profession knows more about the pathological conditions brought about by disease and much less about the physiological basis of optimum health. Clinically many of us have labelled subjects as "good" "fair" or "poor" on the basis of general appearance, colour and texture of skin, lustre of the eyes, presence or absence of subcutaneous fat etc. Presence or absence of physical signs associated with so called vitamin deficiencies *e.g.*, phrynoderma, xerophthalmia, angular stomatitis etc. are of no help in diagnosing lowered state of health or nutrition. In my own small experience I have noticed in the course of large scale nutrition survey in Bengal and Bihar during food shortage of

1943-44, that poor state of nutrition may be associated with a diminished incidence of the physical signs of specific vitamin deficiencies. Experience elsewhere has also corroborated such findings.

The only index to fall back upon seems to be a comparative study of the height and weight figures. Though the method is not very scientific in its concept still in the absence of a better one, it can be used profitably for large scale investigation. A study of the average weight curve of the adults plotted every month has given satisfactory clue as to the state of nutrition (of large scale population groups) in the occupied countries of Germany and Austria. As a matter of fact results of body weight surveys, on a very large scale, in both these countries have proved as a valuable guide in determining the size of ration for the different age, sex and occupational groups of the population.

DR. B. MUKERJI, Calcutta.

Due to his preoccupations as General Secretary of the Indian Science Congress Association, Dr. Mukerji could not take part personally in this symposium. He forwarded his remarks as follows:

In any discussion on the physiological basis of health, the notion 'health' naturally assumes the central position, but this, in itself, is obscure. Health has been defined by some groups as 'freedom from disease', but this certainly does not explain the notion as most of us understand it. Simply 'freedom from disease' is not the true conception of 'health' but there should always be a positive component in it. Health is, therefore, not a neutral state and not simply a negation of disease but is something positive over this neutral state. It depends on preconceptions based on rough experience and secondarily on an estimate of evidences amenable to measurement. Height, weight, acquity of vision, the blood pressure, the pulse rate, the basal metabolic rate, the cardiac output, etc. represent such measurements. Measurements of value have not obviously been developed to estimate all the essential functions, which taken together constitute the physiology of a person. Of the tissues, organs and systems of the animal body, not one falls as yet in a category, of which it can be said that the measurements available taken together describe that structure adequately. How then is it possible to define 'health'?

Meanwhile, it is important to develop the notion 'normal'. Of normal, it must be possible to say, normal in respect to what? Normal is not a measurement nor a conception. It results from experience on the part of a critical observer. Based on a large number of such observations, we have certain definite figures, from which we ordinarily draw averages and this average figure is usually considered as 'normal'. However, there are many fallacies in this and it should be possible to state that the normal is with respect to a particular condition, such as age, weight, height, etc. and not to indicate a comprehensive physiological state of the human body, which is not a static condition but of constant vibration and adjustment.

A very laborious study is needed in India to indicate the *normal levels* of health studies through the various criteria mentioned and then only it will be possible to indicate what is the true physiological basis of health. Without that data, no scientific estimation could be possible.

There are many factors that bear upon an individual's prospects for a long life. One that will probably remain outside human control is the heritage of longevity bequeathed by the family, for studies that have been conducted on the subject indicate that this characteristic is a hereditary trait. However, gains in average longevity since the beginning of the century have been greater than the differences observed between the best and poorest classifications by parental longevity. The average individual can, therefore, more than overcome biological discrimination by personal and collective action toward the intelligent control of environment, although he cannot altogether avoid the consequences of the qualities that are with him.

It is now fairly well established that a direct relation exists between social-economic status and mortality. The prospects for a long life are best in the most favoured classes and poorest in the unskilled labouring classes. The average length of life has also been found to vary with geographic locality, occupational hazards, marital status, mental ailments, etc. Evidence of value is accumulating that through the practice of better personal hygiene and by means of a well ordered existence, the average man may add many years to his expectation of life. The possibilities along these lines have never been fully explored. There are many instances of greatly improved physical condition and of enhanced longevity through the practice of personal hygiene, and the adoption of a 'balanced diet' suitable to the individual according to his body build and occupation.

By some inexorable law, still to be discovered and clarified, nature has allotted to man a life span of about one hundred years. But very few lives complete this span. The great majority are constantly exposed to adverse influences in their environment that threaten either to destroy their existence or to accelarate the degenerative processes. However, even in the so called 'healthy' individuals, there is evident a physical degeneration of his cardio-vascular system, including blood and lymph, his digestive system, his skeleton, his locomotor system and teeth, his skin, his glands of internal secretion, including thyroid, para-thyroid and pituitary, his reproductive system, his nervous system, his eye, ears, and his personality, which cannot ordinarily be accounted for by the onset of disease. Pathological conditions of course are definitely known to exacerbate these changes and we have plenty of evidences of young people getting 'old' at ages, where others are in the enjoyment of buoyant health. How these could be explained still remains a 'closed book' to modern physiologists. Unless the centre of attention of physiology, as a science, is focussed more and more to cellular and cytological changes instead of changes in the large organs and tissues of the body as now, real explanations on many of these obscure phenomena will not be available.

COL. S. D. S. GREVAL. Calcutta.

Col. Greval referred to the standards of Insurance Companies as good guides to the assessment of good health, *e.g.*

(*i*) Height—weight ratio (exception Gurkha troops) (*ii*) Chest expansion, (*iii*) Chest-abdomen ratio, (*iv*) Blood pressure and if necessary, (*v*) Haemoglobin and (*vi*) Endurance (effect of effort on pulse rate etc.).

Col. Greval wondered why these standards have not been applied in various enquiries?

DR. C. R. DAS GUPTA, Calcutta.

Dr. Das Gupta agreed with Dr. Mitra's finding regarding haematological findings being not of much help in the solution of the problem. He supported Col. Greval's suggestion of adopting Insurance Company data for assessing. He said that Hb value was not very low in cases of malnutrition, especially in cases of hypoproteinaemia, when he albumin-gobulin ratio was altered. Regarding effect of diet on health as assumed by haematological standards—Hb, R. B. C., etc.—probably protein, specially animal protein, is not essential in maintaining haematological standards.

In answer to a question by Prof. N. M. Basu, Dr. Das Gupta said that Blood-volume had not been examined in cases of hypoproteinaemia.

DR. G. D. BHALERAO, Izatnagar.

On being asked by the President on the index of assessment of Health in animals he said that it was very difficult to do this. Recently the question of assessing the draught ability of bullocks was discussed in one of the meetings of the Indian Council of Agri-

cultural Research, but there was no concensus of opinion. At present the only critera that appears to be the basis of judging the health of animals is the absence of disease.

PROF. B. NARAYANA, Patna.

Said that intensive research work on the Physiological standards was necessary for assessing health. The data obtained would give some idea of the normals for health. The health of an individual may be judged by his capacity for efficient work.

DR. A. K. BOSE, Calcutta.

It is not always safe to accept standards of normals adopted by the different Insurance Companies as the normal basis of health. As far as the cardiac efficiency test is concerned, he stressed that the response of the heart would differ according to the past performance of the Individual and as such is likely to give anomalous figures. Normal cardiovascular condition of any population could be found out only by a comprehensive investigation including X'ray examination, E.C.G., blood-pressure studies in different conditions, B.M.R., blood-chemistry, family history etc., etc., as has been taken up by the cardiological Society of Bengal.

PROF. G. PANJA, Calcutta.

Besides the Insurance standards, a very important factor namely heredity should be considered as a basis for health and longivity. Inspite of ill-feeding, bad environments & minor diseases, some persons continue to live. Besides there are long-lived families.

Dietetic history is another important standard. *Vitamins* should be a major consideration in this category. Presence of *Ketone bodies* in the blood should also be taken into consideration and this may be a good guide.

PROF. N. P. BENAWARI,, Darbhanga.

Health and longivity are not synonymous and need not always go together. Longivity without health would be meaningless, so one would always wish the two to go together.

Health is primary, since it enables the living organism to attain the state of development at which it can fulfill the primary and essential function of life—*i.e.*, propagation of species.

All animals and living organisms live best in their normal environment and they have the capacity to react to changes in their environment in such way that they can survive inspite of that environmental change. They are also capable of altering their activity quite a lot to suit the occasion. For these, however, there are certain limits—which one calls as Physiological limits. Whenever such limits are exceeded markedly they prove detrimental to health. Similarly exercise within certain limits would cause increase in the efficiency of the body, but extremely strenuous exercise on the other hand would prove deleterious to health. Then again, the body needs nourishment for tissue repair and growth, hence nutrition is very important with regard to maintenance of health. The nourishment must be adequate quantitatively and qualitatively. Thus maintenance of health would need moderation in life so that physiological limits of adaptation of the body are not exceeded very often. It would need adequate nourishment—qualitatively and quantitatively. This forms the physiological basis of health. Health usually would lead to longivity. We are concerned more with the question of longivity since we want to enjoy the pleasures of life for as much time as possible, though health is the more important requirement of the body.

DR. D. V. KARMARKAR, New Delhi.

We are all interested to know the methods of expanding the space of life. If physiological activity is taken as the basis of longivity, it is expected that any method

which reduces the physiological activity should extend the period of life. *Pranayam*, fasting and *Brahmacharya* are some of the methods advocated, though definite information of their utility is not available. Detailed investigations are required in these fields.

PROF. S. K. BASU, Assam.

Anatomical clinics in the U.S.A. are studying the problem of health from various angles. The Anatomical clinics of the Brush Foundation & Bolton fund of Western Reserve University, Cleveland, Ohio, study the prospective parents of the child before it is born and of the child as soon as it is born and at the end of the 3rd, 6th, 9th, 12th 18th & 24th months after its birth and then once a year near about its birth anniversary day. The anatomical part of the study is somatometric and radiological. Besides, biochemical, electrocardiographic, electroencephalographic & psychological studies and fitness tests are done and curves of growth analysed against dietetic, climatic, hereditary, economic & environment background of thousands of apparently healthy subjects. The huge data are statistically treated. Optimum curves and data satisfying all conditions are regarded as normals. Norms for healthy skin, subcutaneous tissues, blood vessels, being height & weight, muscular power & intelligence are thus found out. Determination of date of ossification also marks milestones in the progress in physical health as compared to actual age. The age of the individual, again has been classified into 3 types—chronological, anatomical & psychological. Children & adolescents conforming equally to all these ages are supposed to be growing normally and therefore in the possession of good health. A lag in anatomical or psychological age is properly investigated and steps taken to remedy it without delay. These studies are also known as "Race-betterment" studies, since they tend to encourage fitness and eliminate unfitness of the growing individual in the struggle for existence. The Iowa Child Welfare studies the Chicago, Harvard & Yale University Growth Study Centres and the Society for Research in Child Development (National Research Council, Washington D.C., U.S.A.) are working out optimum standards of health in similar manner. We, in our humble way are trying to follow in their steps. Such studies for finding out the basis of physiological health in adults of our country should be undertaken.

PROF. G. K. GHOSH, Patna.

Anatomically, constitution of individuals can be grouped into 3 types—Hypersthenic, Asthenic and Hyposthenic. These types, as the physiologists claim, depend on various glandular factors. Is it possible from this classification to say whether one type will live longer than the others? The problem of life is still unknown, depending on so many biochemical and biophysical factors—mere details of which are still unknown. Untill we know more about this, the definite assessment of longivity will also be unknown. Ossification studies give a clue to the malnutrition of an individual—but no assessment of his life. Diet and heredity are certainly very important factors in the maintenance of good health. But where ultimately do they lead to in the assessment of longivity of an individual? Many variations are met with daily and one should be cautious in making broad generalisations.

MAJOR N. B. GODRE, Bombay.

Health is the power to heal.

If one fails to heal completely on a given day, his longivity is less the next day—bad health. Vice versa—if one gains more than he loses, longivity increases—*Buoyant* health.

Health means tic Rate of change of longivity *i.e.*, in mathematical language Longivity must necessarily be an accompaniment of health.

DR. M. L. CHATTERJEE, Calcutta.

The standards followed by Insurance Companies in India are based on the figures for standards of health in Europe. 'Norms' for basis of health have to be found

for India and then correlated with figures for longivity. When the Cardiological Society have found out data, as mentioned by Dr. A. K. Bose, and those of height, weight etc. on 10,000 subjects, only these may help to establish standards. Standards for Insurance Companies in India today are not reliable, particularly as the reports submitted to companies are, oftener than not changed for various names.

Norms have also to be found out to determine the amount of exercise that will not be deterimental to an individual for good health and longivity. Environment is certainly a factor in moulding health and longivity. Both external (hygiene, habits) and internal (tissue fluids, drugs and toxic accumulations) factors are to be considered in "environments". Biochemical estimation of tissue fluids may serve as an index for the internal factors, Dr. G. K. Ghosh referred to constitution being asthenic, hypersthenic, etc. Is there any standard for measuring constitution? People of thin constitution are known to have good longivity and good health, if by latter one would mean freedom from disease and possession of a good mood.

DR. KAMALA BHAGWAT SOHONIE, Bombay.

A number of surveys carried out in different periods gives us some idea of the health of their people. If all such data be put together, a lot of useful information may be had to arrive at All-India Standards of health.

PROF. VENKATACHALAM, Cuttack.

Given every other condition adequate for a healthy life, physical exercise and disciplined life necessary to contribute towards well-being more than anything else. This naturally means striking a balance between body processes and mind. Worry and anxiety can reduce longivity in an otherwise healthy body.

COL. S. D. S. GREVAL, Calcutta.

Made some additional remarks regarding.

(*a*) *Food Standards*—are well known as per
  (*i*) the Gazeteer of India (District by District)
  (*ii*) Army rations
  (*iii*) Prison diet

(*b*) *Expection of Life*—had been worked out by the Oriental Life Insurance Co. Ltd.

(*c*) *Height-weight Ratio*—It is a *ratio* and indicate reduction in bulk very well (Army allows concession to the Gurkha troops), and stated in giving opinion on health states of a community, those considerations are of primary importance.

PROF. N. M. BASU, Calcutta.

The question of health and longivity has been agitating the mainds of humans since the dawn of consciousness. Many books have been written on this subject from various aspects of the question. More modern books on this subject are those of Metchnikoff & Wever and the experiment performed about rejuvenation are those of Steinach & Vornoff. Metchnikoff's stress on sour milk as being a very effective agent in promoting healthy flora in intestine and Wever's suggestions about daily routine of walking and periodical long walking accompanied by a diet consisting mainly of dairy products, leafy vegetables and fruits after fifty years of age as conducive to health and longivity have been always kept in the forefront regarding this question. Steinach's opperation is not considered to be an advantage in the promotion of health and longivity, and Voronoff's grafting experiments have not met with as much success as was emphasized. According to Heilbrunn, senescence is probably due to body cells becoming loaded with insoluble waste products which prevent free interchange between the protoplasm and the

environment. There are probably also changes in permeability of cell-membrane and its protoplasmic viscosity. Controlled experiments should be devised to find out how far these theories are correct and what measures should be adopted to present these changes in the body. ....

Prof. N. M. Basu referred to two papers by some Russians. In one the authors described the method of grafting the gum with teeth from a young dog into an ald dog in which the teeth had worn away. In the other paper the author described the effects of such grafting on the health of the old dog, the dog becoming more active and more healthy after the experiment. Experiments of this nature have a great bearing on the prolongation of buoyant health in man.

Referring to Major N. B. Gadre Prof. Basu said that the Engineer tried to evolve a formula correlating health and longivity; but in evolving a formula of this type certain assumptions are to be made and the formula is good only so long as the assumptions are valid. In the case of health and longivity, we have not yet found the criteria which will enable us to evolve a formula. Naturally, therefore, any attempt in this direction will not be fruitful in present state of our knowledge.

K. Mitra (New Delhi)

Col. Greval has suggested the use of height and weight ratio and referred to the norms for health collected by one of the Insurance Companies (Oriental?) few years ago in India. Apart from a comparative study of the actual height and weight figures, I am afraid the ht|wt ratio has so far not been found to be a reliable index. He has also referred to the dynamometer and endurance test. Theoretically, dynamometer readings and endurance tests do seem to measure fairly accurately the state of physical fitness in subjects under investigation. But unfortunately there are so many snags on account of variables over which we have no control, that its use in routine survey and interpretation of results become difficult.

Dr. Das Gupta has referred to the accuracy of Van Slyke's copper sulphate method for estimating the specific gravity of blood. All that I had implied was that the technique of relative density gradient with light paraffin and bromobenzene was much simpler and no less reliable.

For the information of Dr. Bhalerao who had referred to the nutrition level in animals I would like to state that at the Rowell Research Institute, Aberdeen an ambitious scheme has been launched to study the effects of higher plane and low plane nutrition in animals on all aspects of their physiology including immunology.

Prof. Narayana has made a valuable suggestion about working out the norms for various physiological indexes. Probably he might remember that about 5 years ago at Delhi, at a symposium "on the position of physiology as an independent science" under the chairmanship of Prof. A. V. Hill, I had urged for close collaboration between the departments of Physiology and Public Health. Prof. Narayana is at the helm of the local medical college and I sincerely hope that he will do his best to create a chair of Public Health (or Social medicine as it is termed in some of the universities in the U.K.) in his own institution and thus forge the first link in this collaborated interdepartmental investigation on physiology of health.

Dr. A. K. Basu has referred to the cardiac efficiency test, as a measure of the state of health, and the survey he is carrying out with 10,000 children. I would like to refer him to this connection, to the work of Dr. Ancel Keys, Professor of Physiological Hygiene at Minnesota on the subject of experimental starvation and rehabilitation of about 30 healthy adult young men who volunteered to act as 'human guinea pigs' on a long term investigation. Cardiac efficiency has also been studied by a M.R.C. unit working in Germany and the catheterisation of the heart has been done in a group of cases to study the total blood volume. It is expected that these reports when finally printed by the Medical Research Council, would help to remove some of the lacunae in our knowledge of health and nutrition.

It may interest Prof. Banwari to know that one of the reputed nutrition workers in U.S.A. had suggested some years ago that the aim of nutrition work is to create conditions by which the characteristics of youth are preserved for the longest possible terms in the life of any one individual.

Prof. S. K. Basu has referred to a very interesting method of approach to the problem. The norms for chronological and skeletal ages in adolescents and children have yet to be established in this country. We are fortunate in having him in our midst with the necessary technical knowledge to study the problem, and I would strongly urge that he may pursue this line of research on the X-ray photograph of adolescents. Certainly funds are needed for undertaking such investigation and we can hope that the various official and non-official bodies doling out money for research would give Prof. Basu's application the consideration it deserves.

Our learned chairman Prof. N. M. Basu has suggested the use of ACH Index for determination of the state of nutrition. About 10 years ago I did play about with the special gadgets for taking the arm chest and hip measurements of children. As far as I can remember I had covered about 10,000 children above the age of 2 years and upto the age of 12 years, using the standards prescribed by the American Child Health Association. After final compilation of the data it was found that the technique 'selected' as malnourished a very large percentage of children who were not in a poor state of nutrition according to the naked eye clinical examination, and missed an equally big percentage of children who were classed as 'poor'.

Finally I would like to inform Dr. Bhagwat that at the last meeting of the Nutrition Advisory Committee held last month at New Delhi, a sub-committee has been set up to study the problems connected with adoption of uniform methods in the evaluation of nutritional status in this country.

ROLE OF ELECTRONICS IN MODERN ENGINEERING PRACTICE

(SECTION OF ENGINEERING AND PHYSICS)

S. V. CHANDRASHEKHAR AIYA, Poona.

In 1897, J. J. Thomson discovered the electron. This constituted a landmark in the field of pure science. This discovery led to the development of Electronics which has become an essential science in almost all the branches of engineering. In its broadest sense, electronics includes all electrical phenomena, because electric conduction involves electrons. This is a very wide definition and has to be narrowed down. According to the American standard definition of electrical terms, electronics is defined as that branch of science and technology which relates to the conduction of electricity through gases and in vacuo. The discussion of the subject will be limited to this narrower sense.

Thermionics and photo-electricity constitute the starting point of electronics. A metal filament or a coated cathode emits electrons when heated. Similarly, certain metal targets when illuminated by light emit electrons. These electrons flow to a positively charged electrode and, in a vacuum, this electron flow or current depends on the potential of the electrode with respect to the cathode. There is no electron flow if this electrode, called the plate, is at a negative potential. This explains the rectifying property of the valve which has diverse applications. If a mesh of wire is inserted between the cathode and the plate, a small potential given to this grid varies the plate current to as great an extent as a much larger potential given to the plate. This explains the amplifying property of the triode valve. If there are no such grids, the plate current depends on the potential applied to each of them. Hence, if these voltages are functions of time, the plate current will have currents corresponding to the frequencies of these voltages, their harmonics and their sum and difference frequencies. This is known as the mixing property of the valve. If a vacuum tube is filled with a

small amount of gas there is no plate current till the effective electrode voltages equals a certain critical value dependent on the ionisation potential of the gas, when the current shoots up to a maximum. This is the property of the thyratron. Electrons emitted from a source can be focussed into the form of a beam by subjecting them to suitable electrostatic fields. Such a beam is made visible by allowing it to fall on a fluorescent screen. If the beam is subjected to an electric field in its path, it will be deflected, the magnitude of the deflection being proportional to the applied field. The beam can thus be deflected in two perpendicular directions if necessary. This is what is done in a cathode ray oscilloscope. By applying a saw-tooth wave type of voltage to a pair of horizontal plates in the oscillograph, the spot on the screen can be made to sweep across the screen in a time depending on the period of this voltage. By applying an unknown voltage to a pair of vertical plates, the wave form of the latter can be studied. A saw-tooth wave type of voltage can be generated by using valves. An unknown voltage can, if necessary, be amplified by valves and applied to the vertical plates.

It is these few facts that have led to the diverse applications of electronics in many fields. Any physical change can, by suitable means be converted into an electrical one. Thus a change of length can be converted into a change of electrical resistance or capacity. Oscillations of small amplitude can be converted into varying e.m.f.'s. Changes of resistance or capacity stated above can be made to produce corresponding voltage changes. All such voltages, however small, can be amplified by a bank of valve amplifiers and recorded or delineated on an oscillograph which has the electron beam acting as an inertialess relay. Any voltage which is a function of time can, if necessary, be converted into a direct current and observed as such by use of a d.c. meter by making use of the rectifying property of the valve. There are, besides, other methods. Change of resistance, capacity, etc., can be made to change the frequency of an oscillatory circuit and the change of this frequency can be observed by mixing it with a constant frequency generated by another oscillator and observing the beat note.

The applications of the above principles will be illustrated by considering a few typical cases in actual practice and explaining the superiority of the electronic method over other existing methods.

Testing of Materials

Constructional material include not only metals such as steel but also stone, brick, tiles, asbestos, cement and mortar. The traditional method of measuring the Young's modulus employs the extensometer. This is not speedy and requires great care. Further the shape of the specimen required for this test is one which is difficult to obtain with building materials. An electronic method of carrying out this test has been developed by Grime. A seven to fourteen inch rod is prepared and mounted horizontally at the centre by means of a wooden grip. To one end is attached a 1|32" iron armature which comes in front of a U type magnet with a coil wound on it. The latter is connected to the plates of an oscillograph. The rod is struck with a hammer at the other end and the frequency of the a.c. induced is measured by studying the wave form on the oscillograph. From this, Young's modulus can be calculated. The accuracy is within 2%.

Before using timber, it is very necessary to know its moisture content and it is cumbersome to estimate it by the usual methods. In the last few years, electronic instruments have been developed on a commercial scale for the purpose. In one method, timber is inserted into a condenser and its capacity depends on the moisture content of the timber. Change of capacity changes the frequency of an oscillator and this is determined by mixing this oscillation with a constant frequency oscillation and observing the heterodyne note. In another method, the resistance between two points in the timber is measured electronically. Measurements of moisture content is accurate to about 2% up to about 20% moisture content.

Bars, rods, etc., are used in structural work. If any of them have developed a crack of magnitude exceeding a specified value, they are unsuitable. The detection of such cracks by manual labour is tedious. At present this is done on a commercial scale by electronic methods. There are two high frequency oscillators. The rod is passed through the coils of the oscillators. When there is a crack, the resistance changes due to skin effect and this changes the frequency of an oscillator. The beat note is amplified and measured by a valve voltmeter. The meter can be calibrated and it is possible to detect cracks from 1|1000 to 1|4 of an inch.

Re-Inforced Concrete Construction

The behaviour of reinforced concrete piles during driving is a matter of considerable interest to the civil engineer. The nature of the stresses created in the head of a concrete pile by the impact of 'the falling monkey' has been recorded by the use of a piezo-electric crystal. The crystal was housed in a metal tube, its end faces being located on metal pistons with which the caps stopping the ends of the tube were in contact. Thus the pressures in the concrete were directly applied to the ends of the crystal. The output of the crystal was amplified by valves and fed to an oscillograph. By placing three crystals at the ends and middle respectively, impulse pressures at three points can be simultaneously obtained. It was found that the maximum compression at the foot was about twice that at the head. Following the rebound, tensions are produced at the foot and the middle of the pile. The experimental results agreed with the calculations.

Structural Engineering

The close design of bridges, buildings, ships and aircraft has in the past been greatly restricted by the inability to determine the extact proportion of the total stress that is taken by the various members under practical conditions. To secure the necessary margin of safety, a large factor of safety had to be allowed. This is popularly known as the engineer's factor of ignorance. The necessity of designing aeroplanes with as low a margin of safety as possible led to the development of the electrical strain guage. A resistance wire is cemented to the member under investigation and forms one arm of a bridge, a similar one constituting the other. When the member is strained, the wire becomes longer and its cross-section decreases. This disturbs the bridge balance and the small voltage so obtained is amplified and fed to a meter or oscillograph. An extension of this principle is the twelve channel recorded developed during the last War. It is difficult to design a ship's hull because it is largely inaccessible. For the purpose of design, it is very necessary to obtain records of the forces acting at various ship's speeds and under different sea and weather conditions. This was achieved by designing a twelve channel electrical strain guage.

The same principle can be employed to record the very low frequency vibrations of a member under stress although it has not as yet been done.

Mechanical Engineering

One of the most interesting applications of electronics is in the development of the electronic engine indicator. To measure the power input to the cylinder and to check the setting of valves, a graph is required connecting the cylinder pressure at any instant with the position of the piston or erank. The standard mechanical indicator consists of a small vertical cylinder which is designed to screw into an orifice in the wall of the engine cylinder and is fitted with a light piston and piston rod. A straight line motion is interposed between the rod and a stylus which records the movements of the indicator piston, suitably magnified, on a chart clipped to a small drum. The drum rotates in synchronism with the engine piston. This type of instrument is expensive and accuracy can only be obtained if the friction and inertia of the moving parts is kept down to a

minimum. This was all right for the simple reciprocating steam engine but did not suit the internal combustion engineers for which a diaphragm of the aneroid barometer type with mirror magnification was adopted. Even this does not suit high speed auto and aero engines. The electronic engine indicator is useful here and for other purposes. The cylinder pressures are converted into voltage fluctuations by fitting a piezo-electric crystal in place of the small piston and cylinder into the orifice in the engine cylinder wall. The output is amplified and passed on to an oscillograph. The horizontal travel of the oscillograph beam is governed by a photo-cell actuated by a light beam which is intercepted by a cylinder cam mounted on the engine shaft. For speeds above 1000 r.p.m., the electronic engine indicator is the most suitable and, at present is the only method available.

Induction Heating

The basic principle of induction heating is simple. When an a.c. is passed through a coil, a piece of metal placed inside the coil is heated by the currents set up by induction. But the important point is the fact that the depth of penetration depends on frequency. At 2000 c|s, heat penetrates to 1|8'' while at 200 Kcs|s, the depth of penetration may be only 1|50''. Hence by proper choice of frequency, the depth of penetration can be controlled. Consequently, induction heating is the only method available for localised heating or zonal hardening of metal surfaces. The power requirements are not heavy either. About 2 Kw of power output is adequate to heat each square inch of surface. The a.c. power is generated by valve oscillators and power amplifiers.

Closely allied to induction heating is dielectric heating which is adopted for non-conductors. The material to be heated is placed between two metal plates connected to a source of high frequency supply. Heat is produced throughout the area of charge and at a very rapid rate. The frequencies employed vary from 5 to 50 Mcs|s and power requirements vary from 1|2 to 200 Kw. To illustrate the superiority of this method, an example may be given. In the plywood industry, laminated sections require an elevated temperature to dry the adhesive bond. This takes 10 to 12 hours or more in a drying room. With dielectric heating, the time taken is just the time required to apply the holding clamps in the other method. Dielectric heating is also employed in modern dehydration of food.

Electrical Engineering

Electronics has its widest applications in the field of electrical and electrical communication engineering but since it is not the purpose here to dwell on this aspect of the subject, only a brief reference can be made. The recent developments in high voltage rectifiers have opened up afresh the possibilities of d.c. transmission. For spot, seam and pulsation welds, electronic control is indispensable. Electronic control is widely employed in motor speed control, a.c. relay and power circuits, servo-gadgets, etc. Latterly, electronic methods of testing are rapidly displacing the older methods. Electronic meters are invaluable for no-load tests on machines. The cathode ray oscillograph is being widely employed for steel sorting, surge and transient analysis of circuit breakers, cables transformers, etc., and for locating armature and motor faults in machines. Modern communication engineering, both wire and wireless, is entirely dependent on electronics.

Other Applications

A few typical and salient examples from some of the more important branches of engineering have been given to illustrate the application of electric methods. There are, however, several others. In geophysical exploration, the technique is essentially electronic in both the electrical and seismic methods. In the manufacture and testing of explosives and in military engineering work generally, electronics has wide applications. For furnace temperature control and, generally, for all automatic control apparatus,

electronic apparatus is preferred to most others. All such existing and possible applications can easily be visualised on the basis of the principles enunciated at the outset.

When the electron was discovered in 1897, it was hailed as a great discovery in the realm of pure physics. The last fifty years have shown how true this statement was. That is not all. As has been explained in this note, the discovery has had a very important part to play in he field of applied science. The most gratifying part of all this is the fact that J. J. lived to see the greater part of the remarkable progress that pure and applied physics made as a result of his simple but epoch-making discovery!

A lively discussion followed in which several members including Mr. Sen and Dr. Ramdas participated. Prof. Aiya replied to the points of the discussion and the meeting terminated.

TREATMENT OF MENTAL DISEASES IN INDIA

(Sections of Medical and Veterniary Sciences and Indian Psychiatry Institute).

DR. NAGENDRANATH DE, Calcutta, presided.

I. R. BROCKLESBY DAVIS, Ranchi.

(Psychiatry in General Practice.)

Psychiatry is the Cinderella of Indian medicine. No medical man in India can deny the truth of this. While other branches of medicine have made progress which can compare with medical progress in the rest of the world, psychological medicine has been left far in the rear. Various estimates have been made of the amount of psychological suffering in this country. To make an accurate estimate is a very complicated and difficult business. Of course mental illness cannot be easily defined and measured in the same way that the extent of physical illness can be estimated. Any doctor can tell if a patient has fever, or dysentery, or cholera, or tuberculosis, but the majority of sufferers from neurosis and the less obvious types of psychotics have to face a whole life of misery and ill-health as real as that of the physical sufferers, without sympathy, treatment or hope of cure because others cannot understand and appreciate the state of affairs.

But I think it would be true to say that the volume of mental ill health in India is as great as the volume of physical illness which the Surgeons, for instances, are called upon to deal. Every University in India has a department devoted entirely to surgery and a Professor whose sole business is surgical teaching and research. Moreover, every general practitioner is trained in the procedures of minor surgery and is competent, more or less, to carry them out.

In this Paper I shall try to indicate ways in which a general practitioner can recognise psychological illness, the methods of treatment at his disposal and within his scope and how he can relieve the psychological sufferings of his patients.

In past years the light of Indian psychiatry has been hidden under the bushel of the isolated lunatic asylum, isolated in thought and space from the University, and confined within four walls. There must be a new spirit which shall bring psychiatry into the medical colleges, into the minds of the doctors, in their routine professional practice.

One of the main principles of medical practice is that the patient must be examined completely. I am referring of course to scientific medical practice. I believe the Ayurvedic practitioners are able to arrive at a diagnosis and prescribe treatment merely by feeling the pulse aided by some strange process of institution. Not that I would discount either method in itself. The pulse indicates many things to the physician and intuition brings to him all the resources of his unconscious knowledge. But a partial view of the patient is the cause of many disastrous mistakes in diagnosis. Patients have

had their abdomens opened in a vain search for an inflamed appendix when a painstaking search of the stool would have revealed the Amoeba histolytica, or an ordinary examination of the chest would have revealed pneumonia, or when attention to the nervous system would have indicated the gastric crisis of tabies. Surely, a man's mind is of as much importance to him as his stomach, or liver, or lungs, or intestines and yet how seldom does the Doctor pay attention to the mental state in addition to examining viscera. The consequences of this defect in clinical practice are far-reaching. In many patients the physical condition causes but trivial inconvenience by comparison with the neurotic ailment which goes unrecognised, untreated and unrelieved. We can all think of unfortunately people who have been subjected to many forms of physical treatment, surgical, medical and gynaecological, with no benefit, who were really in need of psychological help. Confidence in the doctor and the medical profession as a whole is undermined. In the cure of all disease it is nature and the patient's constitution which makes the cure. Man only helps and nature's main weapon in fighting disease is a strong and healthy mind. By giving support to the mind of a sufferer from any disease the doctor can put into the hands of nature this bright and shining weapon of a strong and healthy mind. Again I refer to the indigenous system of medicines, this time in more flattering terms—the Kaviraj of India and the Christian science practitioner of the Western world do indeed sometimes produce most striking curative result, and in many cases this is because they strengthen the mind of the patient against the disease by means of suggestion, and be it noted that suggestion is only one of the principles of psychiatric treatment.

No Doctor can therefore afford to neglect the psychological make-up of each of his patients. This part of the clinical examination need not be a very lengthy business in most cases, but it is of the utmost importance to bear it always in mind. Obviously, there are many patients whose illnesses are mainly physical and who by their positive and hopeful attitude show that they require no sort of psychological help. Provided the doctor is unerring in his diagnosis, and there exists some form of effective treatment which he prescribes, these patients make a rapid and satisfactory recovery. But the doctor must always be alert to certain psychological manifestations which may indicate that the disease is either partly or wholly psychogenic in nature.

By far the most important of these indications is Anxiety. The patient may express anxiety, either in his demeanour or in words, which is out of proportion to that which would normally be produced by the physical illness from which he is suffering. Physical signs of anxiety may also be present, such as tachy-cardia, increassed perspiration, pallor, tremors of the hands and increased tender reflexes.

The second indication is that of apathy. The patient's whole attitude is one of hopeless defeat. There is a lack of normal emotional expression. This condition is far less common than anxiety. It may indicate a further stage in the anxiety process in which case the patient has been afraid of something for so long that he has lost all ability to resist or it may indicate some more deep-seated psychological disorder.

The third indication I would describe as enjoyment of ill-health. The patient describes his symptoms with obvious gusto and in great detail and ensures that the Doctor misses nothing. Very often he has written all his symptoms down on a piece of paper. He defies the doctor to cure him or in fact to take away any of his symptoms which are his own and nobody elses. The symptoms are unique and he lays emphasis with an air of triumph on the fact that they prevent him taking part in this or that activity. Janet, the famous French psychiatrist, described this condition as "La Belle Indifference". It is an indication of the hysterial type of patient.

The fourth indication of psychological illness is Insomnia.

If any of these indications come to light in the ordinary routine examination of the patient then it is necessary to investigate the mental state in more detail. A complete life history should be obtained with particular reference to interpersonal relationships

and the sexual life and by doing this it is usually possible to make a rough estimate of the basic intelligence of the patient, and the strength or weakness of his personality. Full scale intelligence and personality tests are of course beyond the scope of the general practitioner.

Having obtained all the information one must ask these questions:—

(*a*) as regards quantity: to what extent is the mental factor responsible for the symptoms compared with the physical factor?

(*b*) as regards quality: what is the type of psychological maladjustment?

The answer to the first question is apparent from the physical signs of the disease and the indications of psychoneurotic symptomology.

Illnesses should be classified according to the proportion of physical and psychological element and fall into three categories:—

(*i*) The disease is mainly physical but there is a superimposed neurotic element of mental maladjustment. Purely physical treatment will not suffice to bring the patient to state of complete health and recovery may be greatly delayed if psychological help is not given concurrently with physical treatment.

(*ii*) The condition may be psychosomatic in nature. Many diseases and syndromes come under this heading. In them the physical and mental factors are approximately of equal importance and interact with each other in a complex interwoven pattern. Some of the commoner types of psychosomatic illnesses are Hypertension, Hyperthyroidism, Effort Syndrome, Impotence, Migraine, Cardiac Neurosis and Gastric Neurosis. It is essential that the physician should always look on these conditions in the light of psychosomatic medicine. In fact, every general practitioner should be a specialist in psychosomatic medicine.

(*iii*) The illness may be essentially neurotic in nature. In neuroses (which is syponymous with psychoneuroses) although there may be physical symptoms yet the basis of the illness is purely psychological. The common neuroses are Anxiety State, Hysteria and Neurasthenia. (I will refer to the question of psychoses later).

The type of neurotic element which forms part or the whole of the patient's illness can usually be classified into one of these three common neurotic reactions.

I have indicated above what are the features of Anxiety State and Hysteria. In Neurasthenia, which is far less common than the above two, the presenting symptom is severe nervous exhaustion. Any sort of activity exhausts the patient unduly. In addition, symptoms of anxiety may also be present and there is commonly severe sexual disability ranging from premature ejaculation to frequent spontaneous seminal emissions, both nocturnal and diurnal, which are often brought on by any sort of stimulation of the genital regions such as may be produced by riding a horse or a bicycle or even merely sitting in a moving vehicle. Low backache is almost invariable. Headache is common and in females menstrual disorders are usually present.

Insomnia is of course a common symptom of any type of neurosis.

Although no general practitioner should be called upon to treat cases of psychoses except for giving them "first aid" during the time before they can be brought under specialist psychiatric treatment, yet he must know the differential diagnosis between neurosis and psychosis. I cannot go into this question fully here but the main criterion is whether contact with reality is maintained. Neurotics always maintain some sort of harmony with, and continue to react to their environment, whereas psychotics are found to be reacting mainly to the inner processes of their own minds to the exclusion of the outside reality. Secondly, any evidence of hallucianations or delusions almost

certainly indicates the presence of psychosis rather than neurosis. Thirdly, marked alteration in the emotional state such as depression, elation and apathy, if not obviously produced by circumstances, indicates a psychosis. Fourthly, in depression the type of insomnia may give an indication as to diagnosis. In depression associated with anxiety state the difficulty is often that of getting to sleep whereas in psychotic depression the patient wakes too early and cannot sleep again.

I will here emphasise only one method of psycho-therapy but this is undoubtedly by far the most important and effective method for use by a general practitioner. I will call this "Dispersal of Fear". Fear of one sort or another is the basis of nearly every neurotic illness and if we can relieve fear then more than half the battle is won. According to the psycho-analytical school of Freud, fear has its origin in the early childhood in the fear of castration—of the threat of castration in the male and of castration having already been performed in the female. However this may be, it is possible for the ordinary doctor, without probing very deeply into the unconscious part life, to relieve fear in his patients. The procedure is as follows:—

First, after a thorough examination of the patient he is told that he is not suffering from any serious physical illness or that such physical illness that he has can be successfully treated. I will give two examples of this kind of psychotherapy in general practice.

The first case was a young man of 20 years. I was called to see him in his house because his mother thought he had Influenza of which there was an epidemic at the time, He gave a vague history of two day's fever. He had mild pyrexia and he may well have been suffering from Influenza, but I noted he had all the symptoms of acute anxiety and therefore I made a more complete physical examination than one generally has time for in busy general practice and discovered that the cause of the fever was an acute gonorrhoea which he had been too shy to mention. With the treatment of his gonorrhoea his health, both mental and physical, was completely restored.

The second case was a woman, age 51, who complained of most distressing lower abdominal pain. On examination there were no obvious physical signs but again the symptoms of anxiety were present. Rather than dismissing her with a bottle of medicine I spent some time in taking a complete life history and discovered that her mother died at the age of 51 of carcinoma of the colon. After some discussion she admitted that her real trouble was fear of cancer. The treatment in this case was to have her fully investigated for this condition, arrange for a periodic investigation, and explain to her that this would ensure that if she ever did suffer from this disease it could be treated early and most likely successfully. Her anxiety was relieved sufficiently for her to live a normal happy life again which had been impossible on account of her extreme anxiety.

In addition to relieving fear the general practitioner can often, by his knowledge of human nature, advise as to changes in his patient's mode of living which will reduce psychological maladjustment. But to do this he must have some psychological and psychiatric knowledge and he must be prepared to spend a little extra time on the psychological investigation and treatment of those of his patients who need it. Such time spent will be amply repaid. There are of course those cases of neuroses which do not respond to simple methods of psychotherapy or which are of a severe or of complicated nature which should be referred to the Specialist.

One of the most difficult problems in psychiatry with which the general practitioner is called upon to deal is the psychotic who suddenly becomes acutely maniacal and arrangements cannot be made immediately to get him into hospital. The use of any form of binding by ropes cannot be too strongly condemned. I have seen in my practice two cases where ropes have been used in which obstruction of the circulation had produced gangrene of a limb necessitating eventual amputation. Both these cases recovered their sanity but were minus a limb. By far the most useful measures are intramuscular injections of Somnifene and Paraldehyde by mouth or by rectum.

Somnifene should be given in doses of 2 c.c. and repeated not before six hours. Paraldehyde by mouth may be given in dosage of 2 or 3 drams with an excipient, or 4 drams per rectum with Olive Oil. Paraldehyde should not be given intramuscularly as I have seen many cases of deep abscess produced in this way. Sufficient of these sedatives should be given to produce the excitement to manageable proportions but not to produce unconsciousness. If in spite of these drugs the patient is still unmanageable the wrists and ankles may be tied with carefully padded bandages to the sides and bottom of the bed. In cases where severe mental excitement is associated with physical toxaemia, Morphine is the best sedative but is contraindicated if the hearts or lungs are involved. Needless to say, a case of acute mania or other type of acute mental excitement is as much an emergency as an acute abdomen and should be admitted to hospital within 24 hours at least.

Cases of depression or melancholia occurring in middleaged or old people for no apparent reason should always be treated with respect. The practitioner should know three things about this condition:—

(*a*) There is always a danger of suicide.
(*b*) The ultimate prognosis is on the whole good.
(*c*) Excellent results can usually be obtained by Electric Shock Therapy.

There is no bigger mistake than to think that General Paralysis does not occur in India. This myth has grown up because Wassermann Reactions have not been generally performed in Indian mental hospitals. In any doubtful case of mental disorder the blood W.R. should invariably be performed, and if facilities exist, the C.S.F. should also be examined.

In conclusion, hese are some of the ways in which the benefits of modern psychiatry can reach the suffering massess and they depend above all on the better psychiatric education of the general practitioners.

Dr. N. N. De, Calcutta.

Most of you know, though you often forget, that Tabes and G.P.I. were diagnosed long before the serological reactions came in and in most cases they were diagnosed correctly. The diagnosis was made from definite signs and symptoms. Even today I would depend more upon signs and symptoms than on the serological findings. If I diagnose a case as G.P.I. and then the patient brings a negative blood W.R. report I shall not revise my diagnosis. Blood W.R. is postive only in 60 to 70% of cases of Tabes and G.P.I. Reactions of he cerebrospinal fluid are more constant and should be respected.

Major A. N. Mukherjee, Calcutta.

Convulsion Therapy in Psychiatric Cases

Convulsions are produced in two ways

1. Chemically.
2. Electrically.

Chemical Method consists in intravenous injection of a ten per cent solution of Cardiazol (Leptazol B.P.) which is usually given two or three times a week in the morning in a fasting stomach. Usually convulsion is produced with 5 c.c. of the 10% solution but sometimes double the amount is required to produce a fit.

Description of fits—In about two to five seconds the face of the patient flushes and he coughs and then suddenly experiences choking sensation and unknown fear of death. Then he becomes unconscious and gets violent tonic spasm which later on breaks up into clonic jerks. which continue for about thirty seconds. At this time the respiration

completely stops and the patient becomes cyanosed. The patient at this time may lose control of sphinctres; corneal reflex is usually lost.

After the cessation of convulsion different patients behave differently. Some sleep quietly but others become restless, confused or violent. This excitement stage lasts only for about ten to fifteen minutes after which the patient becomes normal.

(1) The patient instantaneously becomes unconscious, so does not experience pain or fear of death and does not therefore resent treatment.

(2) Psychomotor excitement arises of less intensity than that after Chemical Method.

(3) Difficulties in intravenous medication does not arise.

(4) If no convulsion ensues, immediately the process can be repeated.

COMPLICATIONS

1. Ligamental tears and dislocation of the mandible, shoulder and hip joints
2. Vertebral fractures
3. Occasionally fracture of the long bones like the humerus, clavicle, etc., (often due to bad handling)
4. Danger of flaring up of latent Tuberculosis infection
5. Cerebral hoemorrage.

After this Major Mukherjee described the effects of convulsion in a few cases in which convulsive shock therapy was used by him and how the patients behaved during the convulsion treatment and for sometime afterwards.

MR. SAMIRAN BANERJEE, Calcutta.

I propose to put before you certain facts and considerations of practical value with the occupation treatment of psychiatric cases. I am to make it clear that Occupation Therapy is considered as essentially a psychological method of treatment of mental illness with the help of suitable occupation.

By mental illness I mean mental troubles, either psychotic or psychoneurotic symptoms. No occupation can be considered as definitely suitable and of any therapeutic value unless it can produce a favourable reaction by which I mean the patient may feel a pride in his work and a sense of responsibility in doing it. But the question is how to enlist the co-operation of the patient who generally lives in a state of partial or complete intellectual isolation and inaccessibility from social point of view.

In taking up a case, therefore, what should concern the Occupation Therapist most, I think, is the question of establishing a friendly relation with the patient. And this is a tremendous task, perhaps the most important one.

As we approach patients it is noticed that many patients have got extraordinary fear and suspicion, which may or may not be so apparent. To approach a patient in a correct way the Occupation Therapist has got to disarm himself, so to say, his expression and behaviour and that means a great deal. It is interesting to know, the attitude generally to be taken should be, in a sense, one of a child. Simplicity in expression and genuineness in behaviour must be made clear while taking into account peculiarities of the individual patient. No movement should be in hurry nor with hesitation. One should behave with a patient particularly politely and in a way one would behave with a normal person and his manners should be pleasing, clear and easy. Vulgar and social matters should not be discussed and there should be no threatening of punishment nor any false assuarance given. While paying all attention to a patient there should be no expression of suspicion about the patient although there may be reasons for suspicion about the patient's suicidal or homicidal desires. Attention is to be paid, in a guarded manner, that the patiant may not be much conscious about it. One

must also know when to leave the patient as the patient is to be left in a pleasent mood and not in a condition of bored feeling.

After having established a sort of friendly relation with the patient, through behaviour only, the next task is to listen to the patient and to study the nature of the mental processes without making any contradiction. The purpose is to investigate unconscious and the unfulfilled wishes in their layers.

Gradually is reached a moment and that is the critical moment for the Occupation Therapist. Now what to do—can we follow and support the delusion when present in the patient and act accordingly? I think as we show a gesture of friendship with the patient, just to start, we are to co-operate with the patient as far as possible and to get into a relationship with him of 'give and take.' The Occupation Therapist must be able to take the opportunity to help the patient also to show a gesture of friendship towards the Occupation Therapist, so that the patient may be able to love the Occupation Therapist. After this transferance, quite in a large number of cases it has been seen to male patients and to females who are rather in their middle ages, the Occupation Therapist is more closely identified with mother and to females generally the Occupation Therapist stands in the position of father. Occupation Therapist being loved, his or her work is also loved by the patient.

Now an occupation is to be selected for the satisfaction of unconscious unfulfilled wishes in a symbolical manner in social way. The purpose of selection of symbol is to provide greater pleasure and the purpose of presenting a symbol as approved by society is to minimise the conflicts in the patients due to opposite wishes. Having understood the patient one must know before selection of occupation how far the patient has travelled back in his life, where he is fixed in his regressed state of mind—where the patient is to be considered as a child. The next thing is to deside in which way the route will be the shortest and earliest to divert the aggressive feelings of the patient either from the patient himself or from the system of delusion when present. The patient is to be helped to direct his aggression in a way in which it is to be absored in his occupation in a social manner. The conflict of opposite wishes distinctly takes place between wishes of male and female character. So, a symbol is to be selected accordingly that the patient can focus the aggression on to it just to set apart the two opposite forces—conflicting with each other.

I dare not give interpretation of occupation symbol to psychotic patients in the usual way. In my opinion infinite care must be taken to explain the symbol in occupation on suggestive line and it should never be direct in psychotic cases. In psychotic cases when phantasy is directly known from the interpretations there is a possibility of appearance of new symptoms as interpretations themselves become symptoms sometimes.

In completely demented cases, who are in catatonic condition, and in mental deficiency cases and where orientation is completely lost, occupation which can produce massive painful sensations all over the body, sometimes shows remarkable results. Even in these cases from the very beginning the attitude to be taken must be quite clear to the patient, a friendly attitude, I mean. That indeed helps the patient to maintain the improvement after he has experienced painful sensations.

I may deal now with the question of prescription of an occupation. In prescribing an occupation for each patient some points are to be noted.

(A) There may be two types of patients—(1) Restless type of patients—they include Paranoid, paraphrenia M. D. P. cases (2) Quiet type of patients—they include schizophrenic or dementia praecox and some patients with psychoneurotic symptoms. Restless patients as well as quiet type of patients may be either intellectual, cultured type or just the opposite type. I exclude the criminal type.

(B) Those who want isolation are to be taken in group slowly with coaxing and directions in a suggestive way and those who prefer to work in group only are also to be given some work in complete isolation from others. Heavy exercises and nursing

work according to the physical fitness of the patient generally do imense good. Reward for work is not found so essential, but correct appreciation is essentially necessary to develop a social sense and an attitude. No game or occupation can be said to be exclusively for males or females. Any game or work of any nature can be suitable and of therapeutic value either for a male or female patient, almost of any age. For example, playing with dolls may be prescribed for an old gentleman, writing alphabates may be prescribed for a retired magistrate, lying in the cradle of an infant boy for a while for an old lady, supervision work of a centre of occupation for a boy of fifteen and so on. And these are to be done in a suggestive way. Prescription of an occupation is always subject to the physical and mental condition of the patient at the moment he goes to work or play. Very particular care must be taken about slucidal, homicidal and epileptic patients.

Change of occupation is to be made after a careful study of the unconscious self of the patient. Gradual withdrawal of supervision and delegation of power and responsibility to patients in each occupation centre help the patients tremendously if it can be done in a proper way.

Patients are to be led to talk and they are to be listened to slowly to direct them occassionaly to talk about some particular matter. A particular room or place may be used for holding class and whether a patient can follow the class work or not it does not matter but it helps a patient a great deal to develop an attitude to follow the direction of the teacher without much coaxing. In making a patient work the Occupation Therapsit will apply no force at all and avoid coaxing as much as possible. He will help patients to imitate in a suggestive way, spontaniety being the important thing.

I may now deal with the question of keeping Daily Register for Occupation Therapy.

In the Register, after a roll call, patients are to be marked present or absent. Under the column of occupation mention is to be made in how many occupations, under which group A or B and for what period of time the patient keeps occupied. At least one fortnightly, some points are to be noted in the Remark Column. (1) Does the patient need coaxing and directions in daily routine work? (2) Is the patient developing a sense of discipline? (3) How far the patient has been able to re-establish his relationship correctly with the external world? (4) Has he been more social in his attitude? (5) Can he take inititative in any work in a proper way? (6) Any other remark.

Regarding the type of occupation to be prescribed, generally the following items have been found to be quite useful and any item may be taken either from group A or B, according to mental and physical condition of the patient. Occupation under group A is more of a diversional nature, generally more suitable in the morning and afternoon and group B generally may be taken during noon.

Group A.

(1) Conversation (2) Long way (3) Playing Badminton (4) Football (5) Cricket (6) Hockey (7) Some Indian Games *e.g.*, Ha-Du-Du (8) Chess (9) Carrom (10) Card (11) Snakes and Ladder (12) Ping-Pong (13) Picnic (14) Dancing and Singing (15) Learning and showing Magic (16) Solving Puzzles (17) Swinging in the Cradle of an Infant (18) Heavy physical Exercise.

Group B.

(1) Coloured thread ball making (2) Thread work in frames in a simple and complicated process (3) Clay modelling (4) Rope making (5) Reading and writing with and without directions (6) Nursing with and without direction (7) Tailoring (8) Leather work (9) Toy-making (10) Bag making (11) Mattress Making (12) Spinning whell (13) Handloom work (14) Thread work and carpentry (5) Embroidery work (16) Muffler making on a frame (17) Supervision of some work and doing the same

work under supervision (18) Painting (19) Cooking (20) Boiling water (21) Frying in sufficient oil (22) Washing clothes (23) Gardening (24) To do some work in given time and space.

I proceed now to get into the details of the treatment with reference to treatment of some cases.

Case No. I.

A patient, a man of 42, a highly qualified person suffering for 9 years, spending most of his time in his bed. Complaints were: The British Government planned to destroy his brain with faeces with the help of a great machanised army. Mr. Churchill with his gang organised and engaged dogs to wag their tails before his left eye, forced him occassionally to see naked women dancing before him. He composed a song and used to sing the song in disgust;

"Doggy, my doggy, fæces and women
Come what may, I am not insane,
I believe God, I worship Sun."

Occasionally, he refused food and he had to be fed forcibly, refused to go out of his room, always shouting and abusing his enemies.

I listened to him; I did not give my opinion about his delusions. I enquired, gradually, how long he was being so tortured. He then started telling me all about his early life of struggle. I understood I had won his friendship but only to a certain extent and he just started believing me. I also understood I was given the position of his mother through associations in course of my talk with him. But he had great doubt if his mother really loved him. After a guarded and careful investigation, I came to know he fancied he was victim of malnutrition due to want of milk, as, frequently his father would call away his mother while she would be busy giving milk to the baby.

Now I decided my line of treatment. I started feeding him with milk preparations and assured him there was no want of good milk and milk preparations. Gradually he took from me some food and while taking I asked him to help me in very small matters like giving me a pen from the table, a glass of water to drink and to help other patients to take their food. I do not think those works were of much therapeutic value. The most significant matter was that I could be his friend in various sort of works. I could take him out into the field and he found some work to be done there as well. There on a board I had already written—"grow more food and help those who are in need of it", on another board, "be not shy to show your might in dignity of labour".

These slogans made with special purpose to create interest in social work caught his mind and worked splendidly. He started working on the field. Evidently he was enjoying the work. Frequently, I asked him what more useful work could be done. He gave suggestions first and then he started working in the garden himself.

At present he is working all right—doing his daily duties, looking after himself and his children, managing everything at home independently but he still works in the field, regularly, although his delusions have not disappeared as yet.

Case No. II.

This is a case of a boy of 15. He complains, he was king of Mars and he was a very good man there. "Satan punishes only good people"—he said. So, he sent the good king to hell. He has been living in the hell for millions of years. He wants to go back to Mars again. He does not take any food; says, "I want to die, otherwise I cannot go to Mars and be the king there again—if I take any food God will get angry and I shall not be allowed to go to Mars and be king there."

Coaxing and all attempts to feed him failed. Later an attempt to feed him artificially also failed and he was getting gradually worse in every way. I continued to coax him to talk, sympathetically discussing all about his delusions and slowly he started obliging me in very simple things such as putting the key on the table, helping me to push the table to the corner and so on. One day he told me, "You are a good man, so you are also in hell." I simply smiled but I gave no opinion. I started to take my food in his room and asked him to give me some sauce which he liked very much. I did not ask him to take any food but told him casually that there was no fear to take the food. One night he suddenly screamed and came running to my room, and knocking at my door shouted, "Mother, mother". When I opened the door he saw me but he continued to address me as mother. I asked him, "Who I am? "He replied, "You are my mother." I gave him a sharp jerk and I asked him again, "Who am I?" He again replied, "You are my mother." I asked him if he had any dream. He said he had none.

In course of time he agreed to co-operate, asked me to brush his teeth, to sponge him and help him to put on his clothes and I did all these without any resistance from him. He became quite attached to me being more and more obedient and started doing his work himself. Rapidly he improved, taking interests in surroundings. I took him to the spinning wheel and I spun. He started learning it without being asked to do so. I took him to the play ground and I played with another patient but soon he wanted to play as my partner. He became quite anxious to oblige me, willing to help me in my work. I gave him small but responsible work and he soon started behaving like a normal person.

Case No. III.

A girl of 17, unmarried. She used to keep her eyes shut, refused food, not communicative at all. After some treatment little improvement could be notified for a day or two from time to time.

I knew her early history from investigation from her family members and I started talking about hide and seek game in which she had great joy—then all about dark nights and evenings, dark things and death and life. She explained after a month's effort, it was possible for her to take food in the evening at night after the light is put off. She asked me to keep some food in a closed room under lock and key and to leave the key on the floor of her room so that she might grope in the dark for the key and as she would get the key she would open the door, steal the food and eat it. I arranged as she desired. Slowly she started co-operating with me taking her food regularly along with other people and she was taken out for long walk early in the morning and she had to face the sun while returning. She developed some interest in children. I selected an occupation of making dolls and she took interest in it. Next occupation was to read do lesson to me. I gave her a slate and a pencil and I asked her to do whatever she liked. She was a student in the intermediate class before she was ill. She used to write alphabets of her own accord. She used to come to me regularly to do her lessons and suggested some home task for herself. After some time I gave her promotion to a higher class and in a few months she became a college student again. But still she would occassionally write alphabets. I found out a small boy and she was to teach the boy. During this time of study, frequently I used to give her logenzes and chocolates which she liked very much as a child. She was still behaving like a child. During my talk with her I wanted to know what was her idea about boys and she said, "I hate the boys most." But she gave no reasons for hating boys. I selected a new occupation for her. I taught her to play chess. But she could not attack me in the game; then I proposed, "We better change our positions—you come to mine and let me go to yours." I encouraged her to play aggressive game and discouraged all defensive attempts both in indoor and outdoor game and she started behaving more as an adult.

Lastly Mr. Banerjee exhibited a few charts and demonstrated how to keep records of the progress of a case under occupation therapy either in a hospital or at home.

DR. N. N. DE, Calcutta.

At the request of the audience, Dr. N. N. De, the President gave a short description of the Insulin Shock Treatment. The treatment is done daily (6 days in the week). 30—60 injections complete a course. Ordinary soluble insulin is used and the injections are given early in the morning in an empty stomach. The injections may be given either hypodermically, intramuscularly or intravenously. In a particular patient one route should be used daily. Of the 3 routes the hypodermic is the most effective for cure but it takes longer time every day. The required dose varies in different cases. It is always desirable to begin with a small dose, say 15 to 20 unis, and to increase the dose gradually till the desired amount of coma is produced.

The patient at first experiences a feeling of weakness and drowsiness with a sensation of hunger. Then sweating appears on the whole body and persists for sometime. Towards the latter part of the treatment the sweating disappears and the body becomes dry. Twitches, tremours or convulsions may appear or the patient may become violent. Finally the coma comes on and gradually deepens. When he corneal and conjunctiral reflexes are lost and the Babinski's reflex becomes positive the relief should be given.

The physician must be in constant attendance by the side of the patient. The coma may come on in course of 1½ hours after an intravenous injection and 3 hours after a hypodermic one.

DR. A. K. BOSE, Calcutta.

At what blood sugar level does a patient get coma?

DR. N. D. DE, Calcutta.

As there is no constant threshold level of blood sugar at which all diabetics will pass sugar in urine, one may pass sugar in urine at the blood sugar level of 120 mg. per 100 c.c. while another may not pass any at 240, so there is no constant level of blood sugar in which all hypoglycoemics will become comatose, one may fall into coma at 60 while another may not get it even at 30.

COL. P. N. BARDHAN, Bangalore.

When we give a definite docs of insulin we know what is going to happen and we should make it a rule to terminate the treatment in all cases by intravenous glucose and not try the oral route or the nasal feeding because these in case of semicomatose patients have the danger of passing into the lungs.

DR. R. B. DAVIS, Ranchi.

But if we try the intravenous route every day the vein will soon become fibrosed and intravenous injection will be impossible.

DR. N. N. DE.

The result of insulin injection cannot be predicted with so much certainty as Dr. Bardhan asserts. In a patient of mine who on one occasion had coma with 90 units was found to have no coma with 180 units on another occasion. It was found on investigation that though injections were given every day on empty stomach the difference lay on the amount of food (specially carbobydrates) taken in the previous night.

Dr. De, then described another form of treatment, which is not practised by many psychiatrists but he thought this method should have a definite place in the treatment of schizophrenia and some other mental disorders. He also mentioned that of late various combinations of different methods of treatment are being used. He then summarised the merits and demerits of the different methods of treatment by saying that other conditions being equal there is not much difference in the chance of cure by the different methods taken individually, it being highest with insulin shock, less with convulsive shock and

still less with histamine-cum-insulins. Results are most dramatic with convulsive, less with histamine-cum-insulin and least with insulin shock, chances and relapse are most with convulsive shock, less with insulin shock and least with histamine-cum-insulin. When a relapse occurs the interval between remission and relapce is the least with convulsive shock, longer with insulin shock and longest with histamine-cum-insulin. Various combinations of the different forms of therapy are being tried in different diseases and on different patients with the same disease and are claimed to improve results to a variable degree.

Being questioned how the various shock treatments act in different mental diseases Dr. De said that there are several speculative theories about their action but of them are finally accepted. They are done empirically.

"QUALITY CONTROL IN INDUSTRIAL OUTPUT"

(Sections of Statistics and Engineering)

SRI N. SEN, Tatanagar, presided.

DR. SHEWHART, America, opened the discussion.

Dr. Shewhart explained in broad outline the meaning of "Quality Control in Industrial Output", He then spoke about the statistical technique which had to be used in dealing with the above problems. He observed that a proper sampling procedure and design should be adopted before starting any large scale manufacture of goods. He then stressed the point that by applying statistical technique to problems on quality control in industrial output significant results had been obtained in America and also in other countries, and he concluded by saying that it is high time that a "Quality Control Movement" was started in India.

DR. A. V. SUKHATME, New Delhi.

Dr. Sukhatme said that the application of statistical method to industry, concerning its technical aspect, has mainly centered round control chart methods. The subject owes its development to Dr. Shewhart, and it received increased attention during the war, its value in plant efficiency being fully recognised. He then proceeded to outline the work in this regard which had been actually done in the Tata Iron and Steel Works. He concluded with the observation that the statistical work done in Tata has been mainly one of establishing standards of performance and if there is variability due to assignable causes investigation has been carried out by statistical methods to find these causes from an analysis of routine data.

MRS. C. BOSE, Calcutta.

Mrs. Bose remarked that Quality Control technique developed by Dr. Shewhart in the twenties is nothing but the maintenance of standards in large scale production. It is not possible to achieve complete sameness of manufactured products in spite of (1) the maintenance, at a fairly constant level of quality of raw material, (2) the thoroughness of the machines, (3) the technical skill of the operators and (4) the great care with which the management may execute their work. The science of statistics will give us the limits within which this variation in quality and form of products takes place.

She then narrated the development of Quality Control in Industrial Output in America, India and also in Great Britain and emphasised the need for more attention in this direction in India.

DR. N. S. R. SASTRY.

Dr. Sastry discussed in brief the (1) underlying principles of Quality Control technique and (2) limitations of the above technique.

G. D. MATHUR, Ahmedabad.

G. D. Mathur dwelt on the practical difficulties which he had experienced while working in Calico Mills, Ahmedabad.

M. D. KAPILA.

M. D. Kapila said that the "problem of Quality Control" is a complex one which could only be tackled by the metallurgist, statistician, inspector and operator working in close co-operation. This problem was one that was being actively talked and it would not be long before steel quality could be confined within the narrowest limits. Several other speakers participated in the discussion and they all stressed that Quality Control technique should be properly developed so that it could be extensively and fruitfully employed in Indian industries.

"THE FORECAST OF CROP YIELDS FROM A STUDY OF WEATHER CONDITIONS"

(Sections of Statistics and Agriculture)

SRI KALIDAS SAWNEY, Hyderabad, presided.

DR. L. A. RAMDAS, opened the discussion.

Dr. Ramdas briefly narrated the general possibilities of the development of the subject. He said "Weather factors are primarily responsible for the proper growth and development of a plant and hence they have a greater influence on the crop than manures, variety of seeds, etc. In order to study the subject thoroughly, meteorological department has started a "Crop Weather Scheme". Under this scheme there will be a large number of mateorological stations where meteorological data will be collected". He concluded by saying that the problem was very important and should engage the attention of a committee of experts.

K. KISHEN.

K. Kishen who followed next said that the forecast of crop yield may be done at two stages (1) Preharvest (2) Harvest. For this purpose weather factors alone will not be sufficient, we should study the crop characteristics also along with the meteorological factors.

PROF. P. C. MAHALANOBIS, Calcutta.

Prof. Mahalanobis said that we would go a step forward by predicting the weather in advance from a study of weather reports and then we could utilise this knowledge for forecasting the yield of crop.

PROF. CHINNOY, New Delhi.

Prof. Chinnoy stressed that forecast of crop yield should be based essentially on correlation between environmental factors and growth responses of a crop plant. In support of this he gave a brief account of experiments which he had carried out at the Indian Agricultural Research Institute New Delhi, during 1941-47.

Several other speakers also participated in the discussion.

The Chairman, wound up the discussion by summarising the speeches of previous speakers. He laid special stress on the point that in order to build a good forecasting formula, crop characteristics should be considered along with the weather factors.

LIST OF MEMBERS

HONORARY MEMBERS

BEAUFORT, L. F. De. Director, Zoological Institute, Amsterdam, Holland.

HILL, A. V., F.R.S., 16, Bishop Wood Road, Highgate, London, N 6.

JUNG, C. G., Professor of Psychology, University of Zurich, Switzerland.

RAMAN, Sir C. V., Kt., F.R.S., Nobel Laureate, Indian Institute of Science, P.O. Malleswaran, Bangalore.

SAHA, M. N, D.Sc., F.R.S., F.R.A.S.B., F.N.I., Palit Professor of Physics, University College of Science, 92, Upper Circular Road, Calcutta.

SIMONSEN, John Lionel, D.Sc., F.R.S., Director, Colonial Products Research, Imperial Institute, South Kensington, London, S.W.. 7.

VISVESVARAYA, Sir M., K.C.I.E., Uplands, High Ground, Bangalore.

BENEFACTORS

Burmah Oil Co., (India Trading), Ltd., Digboi, Assam.

Ghadialy, Pestonji, F., F.R.G.S., F.R.S.A., F.B.H.I., (Lond.), M.M.E.A., A.M.A.F., M.I.S.E., Senior Scientific Officer Engineering Intelligence Service, Delhi.

Tata Iron & Steel Co., Ltd., 'Bombay House', Bruce Street, Fort, Bombay.

ORDINARY MEMBERS

[*As at the close of July 15, 1947 (Rule 4). The names of Sustaining Members are marked with † and the names of Life Members are marked with.**]

A

ACHAN, P. Anujan, Government Archaeologist, Cochin State, Trichur.

ACHARYA, C. N., M.Sc., Ph.D., D.Sc., F.R.I.C., Department of Agriculture, Government of India, New Delhi.

ADHIKARI, N., Assistant Manager (Chemicals), Bengal Chemical & Pharmaceutical Works Ltd., 164, Manicktala Main Road, Calcutta.

ADHYA, G. M., B.Sc., E.E., (Wis, U.S.A.), Grad. G. Tech. (Mans.), A.M.I.E., Electrical & Mechanical Engineer, 32B, Mohim Haldar Street, Kalighat, Calcutta.

AGARWAL, Har Narain, Banker, Landlord and Mills Owner, Lakhrajnagar, Aligarh.

AGARWALA, P. M., Director Post and Telegraphs, Construction Branch, New Delhi.

†AGHARKAR, S. P., M.A. (Bom.), Ph.D., (Berlin), F.L.S., F.N.I., 18, Godavari Chal, Shastri Hall, Grant Road, Bombay 7.

AHMAD, B., Ph.D., (Lond.), National Chemical Laboratory, Council of Scientific and Industrial Research, 1, Ganeshkhind Road, Poona 5.

*AHMED, Khwaja Mohammed, Director of Archaeology, Hyderabad-Deccan.

AHMAD, Nazir, O.B.E., J.P., Ph.D., F.Inst. P., F.N.I., Member, Indian Tariff Board, Queen's Road, Bombay.

AHMAD, Nazir, M.Sc., (Hons.), Ph.D., F.Z.S., Director of Fisheries, East Bengal, Comiilla.

AHMED, Nafis, M.A., Professor of Geography, Islamia College, Calcutta.

AHOY, (Miss), Lai L., 38, Dharamtala Street, Calcutta.

AIYAPPAN, A., M.A., Ph.D. (London.), F.R.A.I., Dip. Econ., D.M.A. (Lond.), Superintendent, Government Museum, Egmore, Madras.

AIYAR, R. Gopala, M.A., M.Sc., Professor of Zoology and Honorary Director, Madras Zoological Laboratory, Triplicane P.O., Madras.

AIYAR, S. V. Chandrashekhar, M.A., (Cantab) A.M.I.E.E., Professor of Electrical Communication, College of Engineering, Poona 5.

AIYAR, T. V. Ramachandra, B.A., F.R. Met. S., Meteorologist to the Government of Mysore, Central Observatory, Bangalore.

AIYER, A. K. Yegna Narayan, M.A., Dip-in-Agri., (Cantab), N.D.D., F.C.S., Retired Director of Agriculture, Sankarapuram, Bangalore.

AJREKAR, S. L., F.N.I., I.E.S. (retd.), 855, Shivajinagar, Bhandarkar Institute Road, P.O. Deccan Gymkhana, Poona 4.

ALASAGRACHAR, R. A., B.E. (Retd.), Mechanical Engineer, Inspector of Factories, Department of Industries, Nagpur.

ALEMBIC Chemical Works Co., Ltd., Baroda.

ALI, Mohsin, M.Sc., I.S.E. (retd.), M.I.E. (Ind.), Irrigation Member, Central Waterways, Irrigation and Navigation Commission, Labour Department, Govt. of India, New Delhi.

ALI, Syed Bashir, M.Sc., Lecturer in Chemistry, Muslim University, Aligarh.

ALIKUNHI, K. H., M.Sc., Asst. Director of Fisheries, Fresh Water Biological Station, Kilpauk, Madras.

ALIMCHANDANI, Rupchand Lilaram, M.Sc., Professor and Head of the Department of Chemistry, Karnatak College, Dharwar, M. S. M. Ry.

AMIN, Indubhai, Technical Adviser, Alembic Chemicals Works Ltd., Jyoti Bungalow, Alakapuri, Baroda.

AMIN, Manibhai Bhailabhai, Managing Director. The Sanitex Chemical Industries Ltd., Industrial Area, Gorwa Road, Baroda.

AMRITSAR Sugar Mills Ltd., Rahana Kalan, N. W. Ry., P.O. Rahana Mill, Muzaffarnagar.

APPAJEE, Y., B.A., M.B.B.S., M.Sc., (Lond.), Professor of Anatomy, Medical College, Mysore.

ARBERY, R. C., Controller of Inspection (Metallurgical), Office of the Metallurgical Inspector, Tatanagar, B. N. Ry.

ARORA, Srinath Das, M.Sc., L.T., F.I.C.S., Professor of Chemistry, Jaswant College, Sardarpura, Jodhpur.

ASANA, Jehangir Jamasji, M.A., (Cantab), M.A. (Bom.), Gujarat College, Ahmedabad.

ASOLKAR, G. V., M.Sc., Lecturer, College of Science, Nagpur.

ASUNDI, R. K., B.A., (Hons.), M.Sc., (Bom.), Ph.D., (Lond.), Professor of Physics, Benares Hindu University, Benares.

ATHAVALE, V. B., M.Sc., F.R.G.S., Professor, H. P. T. College, Nasik, Bombay Presidency.

ATREYA, B. L., M.A., D.Litt., Professor of Philosophy and Psychology, Benares Hindu University, Benares.

AULUCK, Faqir Chand, Lecturer in Mathematics, Delhi University, Delhi.

AYER, A. Ananthanarayana, B.A., M.B.B.S., Additional Professor of Anatomy, Central Institute of Anatomy and Physiology, Medical College, Madras.

AYYAR, C. V. Subbarama, M.A., Professor of Mathematics, University College, Trivandrum.

AYYAR, P. Ramaswami, 'Veda Nivas', Malleswaram P.O. Bangalore.

AYYAR, S. N. Venkatarama, Post Box 412, Triplicane P.O., Madras.

AYYAR, T. V. Ramakrishna, Rao Sahib B.A., Ph.D., F.Z.S., Girija' Farm, Mundur P.O. Via Olavakot, Malabar, S. India.

AZIZUDDEEN, Mohd., B.A., G.M.V.C., B.V.Sc., M.V.S., Lecturer in Medicine, Madras Veterinary College, Vepery, Madras.

B

BADAMI, B. K., Director, Veterinary Depart, H. E. H. the Nizam's Government. Hyderabad Deccan.

BADAMI, Rajashekhar C., Department of Chemistry, Karnatak College, Dharwar.

BAGCHEE, Krishnadas, D.Sc. (Lond.), D.I.C., F.N.I., Mycologist, Forest Research Institute and College, New Forest P.O., Dehra Dun.

BAGCHEE, S. N., D.Sc., Lecturer in Pure Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

BAGCHI, K. N., Rai Bahadur, B.Sc., M.B., (Cal.), F.I.C., (Lond.), D.T.M., (Cal & L'pool). F.N.I., Late Chemical Examiner to the Government of Bengal, 5, Ballygunge Place, Calcutta.

BAGCHI, Kanangopal, M.Sc., Asstt. Lecturer, Department of Geography, Senate House, Calcutta.

BAHL, K. N., D.Sc. (Panj.), D.Phil., D.Sc. (Oxon.) F.R.A.S.B., F.N.I., Professor of Zoology, Lucknow University, Lucknow.

BAKER, (Miss) L. A., B.Sc., Professor of Geography, Lady Brabourne College, Calcutta.

BAL, D. V., Rao Bahadur, M.Sc., (Agri.), (Hons.), Ph.D., A.I.C., F.C.S., Agricultural Chemist to the Government of Central Province and Berar, Nagpur, C. P.

BAL, D. V., M.Sc., Ph.D. (L'pool), F.A.Sc., Professor of Zoology, Royal Institute or Science, Mayo Road, Bombay 1.

BALAKRISHNAN, S., Managing Director, Foto Products Limited, P.O. Box No. 49, Bombay.

BALANCE WORKS, D30|32, Deonathpura, Benares.

BANDUKWALA, Kalimuddin T., L.T.C., Ph.D., Manager, Bombay Soap Factory, Ripon Road Cross Lane, Madanpura, Bombay 8.

BANDYAPADHYAY, P. C., Indian Chemical Society, 92, Upper Circular Road, Calcutta.

BANERJEE, A. N., M.Sc., Research Asst., Bose Institute, 93, Upper Circular Road, Calcutta.

BANERJEE, Ajit Kumar, Lecturer, Teachers' Training Department, Calcutta University, Calcutta.

BANERJEE, B. N., Department of Biochemistry, Indian Institute of Science, P.O. Malleswaram, Bangalore. ....

BANERJEE, Basudeb, B.Sc. (Cal.), Dr. Phil. (Munich), Sir J. C. Bose Fellow, Calcutta University, Bose Institute, 93, Upper Circular Road, Calcutta.

BANERJEE, Bhupati Kumar, M.Sc., Research Worker, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.

BANERJEE, G., M.Sc., Indian Chemical Society, University College of Science, 92, Upper Circular Road, Calcutta.

BANERJEE, G. N., B.Sc., F.R.M.S. M.Mic.Soc., P.O. Box. 5576, Bombay 14.

BANERJEE, Jogesh Chandra, M.B., M.R.C.P. (Lond), M.R.C.S. (Eng.), Medical Practitioner, 67, Dhurrumtollah Street, Calcutta.

BANERJEE, K., D.Sc., F.N.I., Mahendralal Sircar Professor of Physics, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.

BANERJEE, Pinakilal, P.O. Ariadah, Dakshineswar, 24-Parganas.

BANERJEE, Prasad Kumar, Statistical Laboratory, Presidency College, Calcutta.

BANERJEE, S. S., D.Sc., M.I.R.E., Assistant Professor of Communication Engineering and Applied Physics, Engineering College, Benares Hindu University, Benares.

*BANERJEE, Sachchidananda, M.Sc., M.B., D.Sc., (Cal.), M.A.D.A. (U.S.A.), P52, Butta Krisna Paul, Avenue, Flat 2C & 2D, Calcutta.

BANERJEE, Tarapada, D.Sc., (Dacca), Lecturer in Chemistry, Dacca University, Ramna, P.O., Dacca.

BANERJI, A.C., M.A. (Cantab.), M.Sc., (Cal.), F.R.A.S. (Lond.), F.N.I., I.E.S., Professor of Mathematics Allahabad University, Allahabad.

BANERJI, Hem Chandra, Vice-Principal, Teachers' Training College, Dacca.

BANERJI, I., D.Sc., F.N.I. University Lecturer in Botany, University College of Science, 35, Ballygunge Circular Road, Calcutta.

BANERJI, J., I.F.S., Capt., I.A.O.C., Deputy Director, Timber Directorate, Department of Supply, New Delhi.

BANERJI, Nabajiban, M.B., Director, Calcutta Clinical Research Association, 10, Rowdon Street, Calcutta.

BANERJI, Sudhansu Kumar, O.B.E., D.Sc., F.N.I., Director-General Observatories, Upper Air Office, Lodi Road, New Delhi.

BANERJI, (Mrs.) Suprabha, B.A., B.T., 26, Ritchie Road, Calcutta.

BARAL, H. C., Chief Transportation Superintendent, Superintendent's Office, G.I.P., Rly. Victoria Terminus, Bombay.

BARAT, C., M.Sc., Dr. Ing., 4, Earle Street, P O., Kalighat, Calcutta, 26.

BARAVE, Raghunath Vinayak, M.Sc., Professor of Physics, Willingdon College, Satara, Bombay.

BARIA, (Mrs.) D.D.H., M.Sc., 'Panorama', 203, Walkeshwar Road, Malabar Hill, Bombay 6.

BARUA, H. P., B.E., I.S.E., Executive Engineer, P.W.D. Assam, Gauhati, Assam.

BASAK, Manindra Nath, M.B., D.T.M., Medical Practitioner, 15, Anukul Mukherji Road, Calcutta.

*BASU, Anath Nath, M.A., (Lond.), T.D. (Lond.), Head of the Teachers' Training Dept., Calcutta University, Calcutta.

BASU, B. C., D.Sc., Entomologist, Imperial Veterinary Research Institute, Izatnagar, Bareilly, U.P.

BASU, Bikash, B.A, (Hons.), (Lond.), Assistant Lecturer in Geography, University of Calcutta, Senate House, Calcutta.

BASU, Charu Chandra, B.A., M.B., Professor of Pathology, Carmichael Medical College, Calcutta.

BASU, Durgadas, M.A., Statistical Officer, Department of Agriculture, Government of Bengal, Bengal Agricultural Institute, P.O. Tejgaon, Dacca.

BASU, J. K., M.Sc (Cal.), Ph.D., (Lond.), F.N.I., Soil Physicist to Government of Bombay, Sholapur.

BASU, J. N., M.I.E., M.A.E., Dr. Eng., Professor of Mechanical Engineering College of Engineering and Technology, P.O. Jadavpur College, 24-Parganas.

BASU, K. P., D.Sc., Ph.D., Dairy Chemist, Indian Institute of Science, Bangalore.

BASU, Minendra Nath, M.Sc., Lecturer in Anthropology, University College of Science, 34, Ballygunge Circular Road, Calcutta.

BASU, N. K., Ph.D., Pharmacologist, Scientific and Industrial Research, University Buildings, Delhi.

BASU, Nalini Mohan, D.Sc., Professor of Mathematies and Head of the Department, University of Dacca, Dacca.

BASU, Narendra Mohan, M.A., Senior Professor of Physiology, Presidency College, Calcutta.

BASU, R. N., M.Sc., M.B., Capt., I.M.S., 7A, Nafar Kundu Road, P.O. Kalighat, Calcutta.

BASU, S., M.Sc., Superintending Meteorologist, Meteorological Office, Ganeskhind Road, Poona 5.

BASU, Santipriya, B.Sc., (Wales), Vice-Principal, Bengal Agricultural Institute, P.O. Tejgaon, Dacca.

BASU, Saradindu Ranjan, M.Sc., Vice-Principal, Teachers' Training College, Corporation of Calcutta, Calcutta.

BASU, Satyendra Prasanna, M.Sc., 44, Girish Mukherjee Road, Bhowanipur, Calcutta.

BASU, Sushil Kumar, M.Sc., D.T.M., D.P.H., Ph.D., (Edin.), Superintending Anthropologist, Anthropological Survey of India, 64 Cantonment, Benares, Cantt.

BASU, Uma Prasanna, D.Sc., P.R.S., F.N.I., 98|4, Surendranath Banerjee Road, P.O. Entally, Calcutta.

BEHARI, Ram, M.A., (App. Maths.), M.A., (Pure Maths.) (Panj.), M.A., (Cantab), Ph.D., Sc.D. (Dublin), F.N.I., Head of the Department of Mathematics, Delhi University, St. Stephen's College, Delhi.

BERA, G. N. M.Sc., Dept., of Physiology, Presidency College, Calcutta.

BHABHA, H. J., B.A., Ph.D. (Cantab.), F.R.S., Tata Institute of Fundamental Research, 53, Pedder Road, Bombay, 26.

BHADURI, Baidya Nath, M.B., Visiting Opthalmic Surgeon, Carmichael Medical College Hospital, Calcutta.

BHADURI, Manindra Bhusan, B.L., District and Sessions Judge, P.O. Jagdalpur, Bastar State.

BHAGAT, M. G., M.A., B.Sc., Ceramic Engineer, 45, Tangra Road, Calcutta.

BHAGAVANTAM, S. D.Sc., Professor of Physics, Andhra University, Waltair.

BHAGWAT, (Miss) Kamala, Nutrition Laboratories, Coonoor, South India.

BHALERAO, G. D., D.Sc., Ph.D., (Fac. Med. Lond.), F.Z.S., F.R.M.S., F.A.Sc. M.M.F., Director, Indian Veterinary Research Institute, Izatnagar.

BHANDARI, Narendra Nath B.A., D.I.C., Ph.D. (Lond.), Assistant Secretary, Central Board of Irrigation, Kennedy House, Simla, S. W.

BHANO, Udai, Mental Healing, 1, Ada Bazar, Indore City.

BHAR, J. N. D.Sc., Secretary, Radio Research Committee, Govt., of India, 92, Upper Circular Road, Calcutta.

BHARADWAJA, Yajnavalkya, M.Sc., (Panj.), Ph.D. (Lond.), F.I.S., F.N.I., University Professor and Head of the Department of Botany, Benares Hindu University, Benares.

BHARGAVA, P. M., M.Sc., (Lucknow.), C|o. Dr. R. C. Bhargava, District Medical officer of the Health, Bijov (United Provinces.).

BHATIA, M. L., M.Sc., Ph.D., Lecturer in Zoology, Lucknow University, Lucknow.

BHATI,, Sohan Lal, M.C., M.A., M.D., B.Ch., (Cantab), F.R.C.P. (Lond.), F.R.S.E., Col., I.M.S., Inspector-General of Civil Hospitals and Prisons, Assam, Shillong.

BHATNAGAR, Sir Shanti Swarup, Kt., O.B.E., D.Sc., F.R.S., F.Inst.P., F.I.C., F.S.C.I., (Hons), F.N.I., Director, Scientific and Industrial Research, Government of India, University Buildings, Delhi.

BHATT, G. V., Indian Aluminium Co., Ltd., Lohardaga, Dist., Ranchi.

BHATT, L. A., M.Sc., Ph.D., (Lond.), Kilachand Devchand and Co., Ltd., 45-47, Apollo Street, Fort, Bombay.

BHATT, U. J., State Engineer, Bhavnagar State, Hill Drive, Bhavnagar, Kathiawar.

BHATTACHARJEE, Kanailal, M.Sc., Department of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

BHATTACHARYA, Ardhendu Sekhar, M.Sc., Sri Aurobinda Asram, Pondicherry.

BHATTACHARYA, B. C., M.Sc., Tech. (Manch.), B.Sc., (Cal.), A.M.C.T., A.T.I., Principal, Bengal Textile Institute, Serampore.

*BHATTACHARYA, Biswa Nath, M.Sc., Asst. Professor of Biology, C. & S. College, Shikarpur, (Sind).

BHATTACHARYA, D. R., M.Sc., Ph.D., (Dublin), Docteur-es-Sciences (Paris), F.N.I., Professor of Zoology, Allahabad University, Allahabad.

BHATTACHARYA, G., M.Sc., Manager, Messrs. Adair Dutt & Co., Ltd., 5, Dallhousie Square East, Calcutta.

BHATTACHARYA, H., B.A., Assistant Industrial Surveyor, Directorate of Industries, Government of West Bengal, 11|B, Fern Road, Ballygunge, Calcutta.

BHATTACHARYA, Punyabrata, M.Sc., Ph.D., Research Officer, (Artificial Insemination), Imperial Veterinary Research Institute, Izatnagar, (U.P.).

BHAUMIK, H. P., O.B.E., M.I.E., (Ind.), 21|1, Mandeville Gardens, Ballygunge, Calcutta.

BHIDE, B. V., M.Sc., A.I.I.Sc., S. P. College, Poona 2.

BISWAS, Haragopal, Research Chemist, Bengal Chemical & Pharmaceutical Works Ltd., 164, Maniktolla Main Road, Calcutta.

Biswas, K., M.A., D.Sc., (Edin.), F.R.S.E., Superintendent, Royal Botanic Garden, Calcutta and Honorary Lecturer in Botany, Calcutta University; P.O. Botanic Garden, Howrah.

Biswas, Mohini Mohan, Research Chemist, Bengal Chemical & Pharmaceutical Works Ltd., 164, Maniktolla Main Road, Calcutta.

Biswas, P. C., M.Sc., Ph.D., (Berlin), Reader in Anthropology, Delhi University, Delhi.

Biswas, S., M.Sc., 16D, Shamananda Road, Bhowanipore, Calcutta.

Bond, C. L., Standard Vacum Oil Co., Ltd., 6, Church Lane, Calcutta.

Bose, A. C., No. 1 "E" Road East, Jamshedpur, Via-Tatanagar,

Bose, A. K., M.Sc., M.B., M.R.C.S., (Eng.), M.R.C.P. (Lond.), No. 3, Creek Row, Calcutta.

Bose, A. N., Bararee Coke Co., Ltd., Kusunda P.O. (Manbhum).

Bose, A. N., M.B., Pharmacologist, Bengal Immunity Research Laboratory, Baranagore P.O. 24-Parganas.

Bose, Aurabinda, Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

Bose, B. C., M.D., D.Sc., D.T.M., Pharmacologist, Bio-chemical Standardization Laboratory, Central Research Institute, P.O. Kasauli (Simla Hills), Punjab.

Bose, Benoy Kumar, M.Sc., D.I.C., A.Inst.M.M., Deputy Chief Assayer, His Majesty's Mint, Baghbanpura, Lahore.

Bose, (Mrs.) Chameli, B.Sc., (Lond.), Statistician, Statistical Laboratory, Presidency College, Calcutta.

Bose, D. M., D.Sc., F.N.I., Director, Bose Institute, 93, Upper Circular Road, Calcutta.

Bose, G., D.Sc., M.B., F.N.I., Professor of Psychology and Head of the Department, University of Calcutta, Calcutta.

Bose, I. B., D.Phill. (Berlin), Pharmaceutical Chemist, Central Drugs Laboratory, Govt. of India, 110, Chittaranjan Avenue, Calcutta.

Bose, J. K., M.A., B.L., Ph.D., (Lond.), F.R.A.I., Dept. of Anthropology, Calcutta University, 46|7A, Ballygunge Place, Calcutta.

Bose, Major Nikhilesh, D.H.Q.M.G., H.Q., Nagpur Area, Kamptee, (C.P.).

Bose, P. C., B.Sc., (Glas.), Offg. Chief Engineer, Calcutta Corporation, Calcutta.

Bose, P. K., D.Sc., Director, Indian Lac Reseach Institute, Namkum P.O., Ranchi.

Bose, Purnendu Kumar, M.Sc., Lecturer, Department of Statistics, Calcutta University, Asutosh Building Calcutta.

Bose, Raj Chandra, M.A., F.N.I., Head of the Department of Statistics, Calcutta University, Asutosh Building Calcutta.

Bose, S. R., Ph.D., F.R.S.E., F.L.S., F.N.I., Professor of Botany, Carmichael Medical College, Calcutta.

Bose, Satyendra Nath, M.Sc., F.N.I., Khaira Professor of Physics, University of Calcutta.

Bose, Subodh Chandra, M.A., Lecturer in of Geography, Vidyasagar College, Calcutta.

Bose, Sudhir Kumar, M.Sc., M.A., Secretary, Indian Psychological Association, 92, Upper Circular Road, Calcutta.

Bose, Susil Kumar, M.Sc., Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

Brahmachari, Nirmal Kumar, M.Sc., 19, Loudon Street, Calcutta.

Brahmachari, Phanindranath, M.Sc., M.D., 19, Loudon Street, Calcutta.

Bulsara, Jal Feerose, M.A., LL.B., Ph.D., Deputy Municipal Commissioner, Municipal Bunglow, Gibbs Road, Malabar Hill, Bombay.

Burman, U. R., M.Sc., Lecturer in Applied Mathematics, University College of Science, 92, Upper Circular Road, Calcutta.

C

Calcutta Industrial Chemical and Minerals Co., Ltd., 43, Dharamtola Street, Calcutta.

CAWNPORE Sugar Works Ltd., Marhwari Factory, P.O., Marhowarh (Saran).
CAWS, A., Begg, Sutherland & Co., Ltd., Marhowrah, Saran District, (Bihar).
CHAKKO, K. C. B.A., D.Sc., (Lond.), M.I.E., (Ind.), Head of the Department of Engineering & Technology, Annamalai University, Annamalainagar.
CHACKO, K. Joseph, M.Sc., Statistical Laboratory, Central Research Institute, Trivandrum City.
CHACKO, P.I., B.A., B.Sc., (Hon.), F.Z.S., Asst. Director of Fisheries (Inland Development), 8, Ormis Road, Kilpauk, Madras 10.
CHAKRABARTI, Mukunda Chandra, Lecturer, Dacca University; 11, Northbrook Hall Road, Dacca.
CHAKRABARTY, Manindra Mohan, M.Sc., Asst. Lecturer in Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.
CHAKRABARTY, S. K., D.Sc., Director, Colaba & Alibag Observatories, Colaba, Bombay 5.
CHAKRABORTY, Saroj Kumar, M.Sc., Asst. Manager (Apparatus), Bengal Chemical and Pharmaceutical Works, Ltd., 164, Manicktollah Main Road, Calcutta.
CHAKRAVARTI, Amulyaratan, B.Sc., M.B., (Cal.), F.R.C.P., F.R.S.E., Consulting Physician and Biochemist, 1, Furriapooker Street, Calcutta.
CHAKRAVARTI, B. C., M.Sc., M.M.G.I., F.G.M.S., Mining Geologist, Indian Aluminium Co., Ltd., P.O., Lohardaga, Ranchi.
CHAKRAVARTI, Bijay Kumar, M.Sc., M.B., Lecturer in Physiology, Presidency College, Calcutta.
CHAKRAVARTI, D. K. B.E., A.M.I.E., (Ind.), Chartered Engineer, 10, Convent Road, Calcutta.
CHAKRAVARTI, Dhidendra Kisore, M.Sc., F.G.M.S., Professor of Petrology, Department of Geology, Benares Hindu University, Benares.
CHAKRAVARTI, Dukhaharan, D.Sc., Lecturer in Chemistry, University College of Science and Technology, 92, Upper Circular Road, Calcutta.
CHAKRAVARTI, Khagendra Nath, M.Sc., Professor of Mathematics, Presidency College, Calcutta.
CHAKRAVARTI, N., B.Sc., (Cal.), M.A., (Cantab), A.M.I.E., (Ind.), Deputy Director, Provincial Statistical Bureau, Bengal, Writers' Buildings, Calcutta.
CHAKRAVARTI, N. P., Ph.D., Joint Director-General of Archaeology in India, Curzon Road Barracks, New Delhi.
CHAKRAVARTI, Nani Gopal, Professor of Chemistry Presidency College, Calcutta.
CHAKRAVARTI, P. C., M.Sc., Professor of Commercial Geography, City College, Calcutta.
CHAKRAVARTI, S. C., Capt. M.B., 97, Kesab Chandra Sen Street, Calcutta.
CHARAVARTI, S. P., M.Sc., (Eng.), (Lond.), D.I.C., M.I.E.F., Principal, Govt. Engineering College, Jubbulpore.
CHAKRAVARTY, B. N., M.Sc., Managing, Agent, The Olympia Chemical Industries Ltd., 102B, Clive Street, Calcutta.
CHAKRAVARTY, K. M., D.Sc., F.Inst.P., Department of Chemistry, Dacca University P.O., Ramna, Dacca.
CHAKRAVARTY, Surapati, B.Sc., M.A., Technical Expert, National Chemical & Salt Works (India) Ltd., 5, Commercial Buildings, Clive Street, Calcutta.
CHAKRAVORTY, C. C., Professor of Mathematics, College of Engineering & Technology, P.O., Jadavpur College, 24-Parganas.
CHANDRA, Ram, M.A., Rai Bahadur, 18, Rajpur Road, Delhi.
CHANMUGAN, W.R., F.R.I.C., D.I.C., Government Analyst, Government Analyst's Laboratory, Colombo 7, Ceylon.
CHANPATIA Sugar Factory, Chanpatia, P.O., Dist. Champaran.
CHARIAR, V. R., Asst. Professor of Mathematics, Science College, Patna.
CHATTERJEE, A., M.B.B.S., Hony. Secretary, Students Welfare Committee and Lecturer in Anthropology, University of Calcutta.

CHATTERJEE, B. K., Dr. es.Sc., (Paris), Anthropological Survey of India, 64, Benares Cant., Benares.

CHATTERJEE, Bimal Kumar, M.Sc., Lecturer in Zoology, Presidency College, Calcutta.

CHATTERJEE, C., Rai Sahib, Head of the Department of Engineering, Nagpur University, Nagpur.

CHATTERJEE, D. N., M.B., (Cal.), M.R.C.S., L.R.C.P., (Lond.), D.B., (Lond.), Blood Transfusion Officer, Government of Bengal, Blood Bank, Medical College, Calcutta.

CHATTERJEE, H. N., M.B., Demonstrator of Pathology, Carmichael Medical College, Officer-in-Charge of Inquiry on Secondary Anaemia and Bone Marrow, I.R.F.A., 9, Romesh Mitter Road, Bhowanipore, Calcutta.

CHATTERJEE, I., Indian Council of Agricultural Research, New Delhi.

CHATTERJEE, Krishnadhan, M.D., (Cal.), Clinical Tutor, Department of Medicine, Carmichael Medical College, Calcutta.

*CHATTERJEE, M. L., M.B., Pharmacologist, Bengal Drug Control Unit, Department of Pharmaeology, School of Tropical Medicine, Chittaranjan Avenue, Calcutta.

CHATTERJEE, Manomohan, B.Sc., (Cal.), Ph.D., (Lond.), A.R.C.S., D.I.C., Professor of Geology, Presidency College, Calcutta.

CHATTERJEE, N. C., Rai Bahadur, 18, Rajpur Road, Dehra Dun.

CHATTERJEE, Nirmal Nath, M.Sc., Lecturer in Geology, Calcutta University, Calcutta.

CHATTERJEE, Pranay Kumar, Statistical Laboratory, Presidency College, Calcutta.

CHATTERJEE, S. D., D.Sc., Research fellow, Bose Research Institute, 93, Upper Circular Road, Calcutta.

CHATTERJEE, S. N., Secretary and Chief Executive Officer, Nagpur Municipality Nagpur.

CHATTERJEE, S. P., M.Sc., Ph.D., (Lond.), D.Litt., (Paris), Head of the Department of Geography, Calcutta University, Senate House, Calcutta.

CHATTERJEE, Sajani Kumar, M.B., D.P.H., (Cal.), D.T.M., (L'pool|), Officer-in-Charge, Bacteriophage Laboratory, Bankipore P.O., Patna.

CHATTERJEE, Satya Charan, D.Sc., F.R.G.S., F.G.M.S., Professor of Geography, Patna College, Patna.

CHATTERJEE, T. D., Engineer-in-Charge, High Power Transmitters, All India Radio, Kingsway, Delhi.

CHATTERJI, A. C., D.Sc., Dr. Ing., Lecturer in Chemistry, Lucknow University, Lucknow.

CHATTERJI, Banbihari, M.Sc., M.B., Medical Practitioner and Lecturer in Physiology, Calcutta University, 82, Dr. Suresh Sarkar Road, Entally, Calcutta.

CHATTERJI, (Mrs.), Bani D.Mus., Sangeeta-Varati, C|o. Dr. S. K. Chatterji, M.B., D.T.M., Ph.D., Chemical Department, Medical College, Calcutta.

CHATTERJI, N.G., D.Sc., D.I.C., A.M.I.Chem.E., Chemical Engineer, Tilak Road, Meerut, (U.P.).

CHATTERJI, S. K., M.B., D.T.M., (Cal.), Ph.D., (Edin.), Chemical Examiner to the Government of Bengal, Medical College, Calcutta.

CHATTERJI, Udayan, M.Sc., Department of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

CHATTOPADHYAY, K. P., M.Sc., (Cantab), Professor of Anthropology, University College of Science, 35, Ballygunge Circular Road, Calcutta.

CHAUDHURI, Anil, M.Sc., M.B., D.T.M., Medical Practioner and attached to Carmichael Medical College, Calcutta.

CHAUDHURI, B. N., B.E., A.M.I.E., M.R.S.I., (Lond.), Consulting Engineer, 1|1A, Mission Row, Calcutta.

CHAUDHURI, Hiran C., M.A., Ph.D., (Lond.), Ph.D., (Edin.), Special Officer, Potatoes, Department of Agriculture, Government of Bengal, Writers' Building, Block No. 1, Top Floor, Calcutta.

CHAUDHURI, J. P. M.B., (Cal.), D.P.H., (Lond.), D.T.M., (L'pool), D.P.H., (Edin.), Health Officer, District 1, Calcutta Corporation; 102|2, Serpentine Lane, Calcutta.

CHAUDHURI, K. C., 56|2, Creek Row, Calcutta.

CHAUDHURI, (Miss) Sujata, M.R.C.P., (Lond.), M.R.C.P., (Edin.), D.C.H., (Lond.), The Countees of Dufferin's Fund Council, Viceregal Estate, Red Cross Building, 20, Talhatora Road, Simla.

CHAUHAN, B. S., M.Sc., Ph.D., F.Z.S., Assistant Superintendent, Zoological Survey of India, Kaiser Castle, Benares Cantt.

CHAVAN, A. R., B.Sc., Ph.D., (Nebraska), Professor of Biology, Baroda College, Baroda.

†CHELLARAM, Kewalram, 9|13, Rattan Bazar, Madras.

CHHABRA, B.C., Offg. Govt. Epigraphist for India, Ootacamund.

CHHAPGAR, S. K., Shapur Baug, B-6, V. Patel Road, Bombay 4.

CHHIBBER, H. L., M.Sc., Ph.D., D.I.C., D.Sc., (Lond.), Head of the Dept. of Geography Benares Hindu University, Benares.

CHIPLONKAR, G. W., D.Sc., Reader in Geology, University of Saugor, Saugor, C. P.

CHIPLONKAR, M. W., D.Sc., 'Herakles Home', Poona 4.

CHITRE, G. D., Rao Bahadur, L.M.S., Plot No. 73, Suparibag Road, Parel, Bombay.

CHONA, B. L., Ph.D., (Lond.), D.C.C., Indian Agricultural Research Institute, Delhi.

CHOPRA, B. N., D.Sc., F.N.I., Zoological Survey of India, Kaiser Castle, Benares Cantonment.

CHOPRA, R. N. Kt., C.I.E., M.A., M.D., F.N.I., F.R.A.S.B., I.M.S, (retd,), Director, Drug Research Laboratory, Jammu and Kashmir, Jammu Tawi.

CHOWDHURY, Amal Chandra, M.Sc., Lecturer in Mathematics, Calcutta University, Calcutta,

CHOWDHURY, Dhirendra Kumar, M.Sc., Senior Chemist, Dept. of Food, (Division iii.), Govt. of India, Imperial Secretariat New Delhi.

CHOWDHURY, K. Ahmad, M.A. (Cal.), D.Sc., (Edin.), M.Sc., F.N.I., Wood Technologist, Forest Research Institute, New Forest, P.O. Dehra Dun, U. P.

CHOWDHURY, J. K., M.Sc.,Ph.D. (Berlin), F.N.I., Professor of Chemistary, Dacca University, Ramna, Dacca.

CHOWDHURY, S. S., M.A., M.Sc., Professor, Science College, Mayapuri, Kodamkuan P.O., Patna (Bihar).

CHUGANI, Gurbux Kadumal, B.Sc. (Agr.), 12, Tikamdas Building, near Sindi Gymkhana, Bunder Road, Karachi.

COATES, Joseph, A.R.S.M., F.G.S., A.M. Inst. Pet., Geologist, The Burmah Oil Co., Ltd. 11, Garasaday Road, Ballygunge, Calcutta.

CROOKSHANK, H., D.Sc., Geological Survey of India, 27, Chowringhee, Calcutta.

*CURSETJEE, (Miss) J.M., 'Behistan', 169, Colaba Road, Bombay 5.

D

*DALAL, Ardeshir, Kt., I.C.S. (retd), Director, Tata Sons Ltd., Bombay House, Bruce Street, Bombay.

DALAL, (Miss) L.M., C|o Mr. V. M. Thakar, M.Sc., Dept. of Organic Chemistry, Royal Institute of Science, Bombay.

DALAL, Phiroz Ardeshir, L.M. & S. (Bom.), D.T.M. & H. (Camb)., Professor of Bacteriology, Grant Medical College, Bombay 2.

DAMODARAN, M., M.A., D.Sc. (Lond.), Professor of Biochemistry, University of Madras, Chepauk, Madras.

DAS, Atulananda, I.F.S. (retd.), F.L.S., F.R.S.E., Arunoday, Laban, Shillong.

DAS, B. K., D.Sc. (Lond.), Professor Zoology, Osmania University College, Hyderabad Deccan.

DAS, Bhupendra Chandra, M.Sc., Professor of Mathematics, Presidency College, Calcutta.

DAS, Biraj Mohan, Rai Bahadur, M.A. (Cal.), M.Sc. (Leeds), Superintendent, Bengal Tanning Institute, P.O. Tangra, Calcutta.

DAS, K. L., M.Sc., M.M.G.I., F.G.M.S., Geologist, Messrs. Dalchand Bahadur Singh, 48, Gariahat Road, Ballygunge, Calcutta.

DAS, N. N., M.Sc., M.B., Lecturer in Physiology, University College of Science, 92, Upper Circular Road, Calcutta.

DAS, Pranab Kumar, B.E., A.M.I.E., Structural Engineer, Martin & Co., Calcutta.

DAS, Ram Saran, D.Sc., Lecturer in Zoology, Allahabad University, Allahabad.

DAS, S. C., M.B. (Cal.), Ph.D. (Edin.), F.R.S.E., Department of Pharmacology, Robertson Medical College, Nagpur, C. P.

DAS, Srimant Lal., M.Sc., Diploma in Education, Assistant Master, Patna Collegiate School, Mohalla Bakergunj Gola, P.O. Bankipore, Patna.

DAS, Tarak Chandra, M.A., Lecturer in Anthropology, University College of Science, 35, Ballygunge Circular Road, Calcutta.

DAS GUPTA, C. R., M.B., D.T.M., Officer-in-Charge, Haematology Department, School of Tropical Medicine, Calcutta.

DAS GUPTA, P. N., Professor of Mathematics, Science College, Patna.

DAS GUPTA, Satindra, M.Sc., , Research Chemist, B.C.P.W., 164, Maniktolla Main Road, Calcutta.

DAS GUPTA, S. N., Ph.D. (Lond.), D.I.C., Reader in Botany, Lucknow University, Lucknow.

DAS GUPTA, S. S., M.Sc., Burmah-Shell Inspector, P.O. Kadamkuan, Patna.

DASTUR, Noshir N., Dairy Chemist, Imperial Diary Research Institute, Hosur Road, Bangalore.

DASTUR, R. H., M.Sc., F.N.I., Plant Physiologist, Institute of Plant Industry, Indore, (C. I.).

DATT, J., B.A., (Hons.), C.E., A.M.I.E., Dt. Engineer, The Concrete Association of India, Mithapur, Patna Junction.

DATTA, Chittatosh, M.Sc. (Cal.), Ph.D. (Dond.), D.I.C. (Lond.), Lecturer in Botany, University College of Science, 35, Ballygunge Circular Road, Calcutta.

DATTA, Paritosh, M.Sc., Biochemical Section of the Chemical Laboratory, University of Dacca, Ramna, Dacca.

DATTA, S., D.Sc. (Lond.), F.N.I., Deputy Secretary, Department of Methods, Organisation and Accommodation, Writers Building, Calcutta.

DATTA, Santosh Chandra, Chemical Laboratory, University of Dacca, Ramna, Dacca.

DATTA, S. K., M.Sc., A. Inst. P. (Lond.), Manager, The Scientific Industrial Co., Ltd., 30, Mount Road, Madras,

DAVENDRA, D. T., Sivali Vidyalaya, Ratnapura.

DAVER, M. B., M.B., B.S. (Bom.), F.R.F.P.S. (Glass.), D.P.H. (Eng.), F.R.I.P.R. (Eng.), Nutrition Officer, H.E.H. the Nizam's Dominions, 54, Sebastian Road, Secunderabad.

DAYAL, B., D.Sc., A.I.I.Sc., Asst. Professor of Physics, Benares Hindu University, Benares.

DAYAL, Jagadeshwari; D.Sc., Lecturer in Zoology, Lucknow University, Lucknow.

DE, A. K., Geological Survey of India, 27, Chowringhee, Calcutta.

DE, Nagendranath, M.B., D.T.M. (Cal.), M.R.C.P. (Edin.), D.P.M. (Lond.), Visiting Physician, Lumbini Park Mental Hospital, Psychological Clinic at Carmichael Medical College and Psychological O.P.D., 128-B, Dharamatala Street Calcutta.

DE, Premankuar, B.Sc., M.B. (Cal.), F.R.C.P. (Edin.), F.N.I., Professor of Physiology, Medical College, Calcutta.

DE, S. S., D.Sc., Lecturer in Food Technology, Department of Biochemistry, Indian Institute of Science, Bangalore.

DEB, S., Docteur-es-Sciences (Paris), Professor of Geology, College of Engineering and Technology, Jadavpur College P.O., 24-Parganas.

DEB, S. (Jr.), Cermic Engineer, Bengal Porcelain Co., Ltd., 3, Moti Sil Street, Calcutta.

DEB, (Mrs) Santa, M.A., B.T., T.D. (Lond.), Dept. of Psychology, University College of Science, Calcutta.

DEEKSHITULA, M.S., M.Sc., Chemist, Govt. Thermal Station, Bezawada.

DEOLALKAR, T. K., M.A., Head of the Department of Physics, Karnatak College, Dharwar.

DEORAS, P. J., Ph.D., 9, Empire Hindu Hotel, Hornby Road, Bombay.

DESAI, R. D., Deputy Head of Chemistry Dept. V. J. T. Institute, Matunga, Bombay.

*DESAI, Shrishkant Varajraj, D.Sc. (Lond.), Ph.D. (Lond.), D.I.C., 2nd Agriculture Chemist, Indian Agricultural Research Institute, New Delhi.

DESHPANDE, Chandrashekhar Dhundiraj, M.A., Dip. Geog. (Lond.), Lecturer in History and Economics, Karnatak College, Dharwar.

DEY, A. N., D.Sc., Dr-es-Sc., D.I.C., Chemical Examinar to Government of India, Opium Factory, Ghazipur.

DEY, B. B., M.Sc., (Cal.), D.Sc., (Lond.), F.I.C., F.N.I., I.E.S., Director of Public Instruction, Mylapore, Madras.

DHAR, A. N. Dr. Ing. (Dresden.), B.Sc., M.I.S.E., (Cal.), Jehanabad, Gaya.

DHAR, Jagattaram, M.Sc., A.Inst.P., Head of the Department of Physics and Mathematics, Indian School of Mines, Dhanbad.

DHAR, S. C., M.A., D.Sc., (Cal. & Edin.), F.R.S.E., F.N.I., Principal, Robertson College, Jubbulpore.

DHARMATTI, S. S., Royal Institute, of Science, Fort, Bombay.

DHINGRA, D. R., M.Sc., Ph.D., Industrial Chemist to Govt. of U. P., Harcourt Butler Technological Institute, Cawnpore.

DHOLAKIA, J. K., M.I.M.E., Agent, Balihari Colliery Co., Ltd., P.O., Kusunda, Manbhum.

DIKHITE, V. N., Dy. Director of Agriculture, Southern Circle, Baroda, Raopura, P.B. No. 96.

DIKSHIT, B. B., Ph.D., M.B., M.R.C.P., D.P.H., Officer-in-Charge, Department of Pharmacology, Haffkine Institute, Parel, Bombay.

DIVATIA, Virmitra Bhimrao, M.A. (Bom.), B.A., (Cantab), I E.S. (retd.), Late Professor of Physics, Gujarat College; 'Pankaj', Parimal Housing Society, Ahmedabad.

DIVISIONAL GEOLOGIST, N. W. I., The Burmah Oil Co., (I.C.), Ltd., 25, Waris Road, Lahore.

DIXIT, K. R., Professor of Physics, Royal Institute of Science, Bombay.

DOJA, M. Q., B.Sc., (Pat.), B.A. (Cantab), A.R.P.S., Professor of Organic Chemistry and Head of the Department of Chemistry, Science College, Patna.

DOLE, Krishnaji Khando, M.Sc., Ph.D., Professor of Chemistry, Fergusson College, Poona 4.

DOSS, K. S. Gururaja, D.Sc., F.I.C., A.Inst.P., F.A.Sc., Physical Chemist, Imperial Institute of Sugar Technology, Cawnpore.

†DUTT, N.L., M.Sc., Assoc.I.A.R.I., Sugarcane Expert, Government of India, Imperial Sugarcane Station, Lawley Road, Coimbatore, S. India.

DUTT, P. K., Coolliery Manager, Karmatand Colliery, P.O. Karmatand, Manbhum.

DUTTA, Ajit Kumar, M.Sc., Research Assistant, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.

DUTTA, Arun Kumar, D.Sc., Reader in Physics, Dacca University, Ramna P.O. Dacca.

DUTTA, Bijon, 15|1|2, Rani Sankari Lane, P.O. Kalighat, Calcutta.

DUTTA, Narendra Lall, Technical Assistant, Council of Scientific & Industrial Research, University Buildings, Delhi.

DUTTA, Paresh Chandra, D.Sc., G. B. B. Govt. College, Muzaffarpur (O. T. Ry.).

EAST India Distilleries & Sugar Factories Ltd., Nellikuppam, South Arcot District, Madras.

*EVANS, Percy, B.A., F.G.S., F.N.I., Chief Geologist, The Burmah Oil Co., Ltd., Britannic House, Finsbury Circus, London, E. C. 2, England.

EZAKIEL, Moses, Professor of Botany, Wilson College, Bombay 7.

F

FASEEH, S. A., M.A., M.Sc., Lecturer in Chemistry, Lucknow University, Lucknow.
FERMOR, Sir Lewis Leigh, Kt., O.B.E., D.Sc., (Lond.), F.R.S., A.R.S.M., M.Inst.M.M. F.G.S., F.N.I., F.R.A.S.B., Late Director, Geological Survey of India; 24, Durdhan Park, Bristol, 6, England.
FORRESTER, C., F.R.I.C., A.H.W.C., F.R.S.E., Principal Indian School of Mines, Dhanbad.
FOWLER, Gilbert J., S.Sc., F.I.C., F.R.C., F.R.San.I., F.N.I., Central Hotel Bangalor.

G

GAN, G. K., Park Avenue, Dhantoli, Nagpur.
GANAPATI, S. V., M.Sc., A.R.I.C., Hydrologist, Fisheries, Freshwater Biological Research Station, Kilpauk, Madras.
GANGULI, A. K., General Manager, The Scientific Instrument Co., Ltd., 11, Esplanade East, Calcutta.
GANGULI, Arun, Z. D. S. (Vienna), 26, Chowringhee, Road, Calcutta.
GANGULI, Dhirendra Mohan, Dy. Superintendent, Statistical Surveys, Indian Statistical Institute, Presidency College, Calcutta.
GANGULY, Dhirendra Nath, M.Sc., Lecturer in Zoology University College of Science, 35, Ballygunge Circular Road, Calcutta.
GANGULY, Dwijendralal, M.Sc., Psychology Department, Calcutta University, Calcutta.
GANGULY, J. B.E., M.I.E., (Ind.), 7|1|A, Mohan Lall Street, Calcutta.
GANGULY, P. B., D.Sc., F.N.I., Principal and Professor of Chemistry, Science College, P.O. Bankipore, Patna.
GARG, Shivchandra, B.Sc., Behari Bhavan, Kaoarganj, Ajmer—Merwara.
GEE, E. R., M.Sc., D.I.C., F.G.S., Superintending Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
GENERAL Manufacturing Company, (Manufacturers of Balance and Scientific Instruments), Sonarpura, Benares.
GEOLOGICAL Survey of India, The Director, 27, Chowringhee, Calcutta.
*GHADIALY, Pestonji F., F.R.G.S., F.R.S.A., F.B.H.I. (Lond.), M.M.F.A., A.M.A,E,, M.I.S.E., Senior Scientific Officer, Engineering Intelligence Service, Delhi.
GHAFFAR, A., M.B., D.T.M., (Cal.), Ph.D., (Edin.), Lecturer in Physiology, Robertson Medical School, Nagpur.
§GHANDY, Sir Jehangir, Kt., C.I.E., B.A., B.Sc., M.I.E., F.Inst.E., M.I.S.I., Agent, The Tata Iron & Steel Co., Ltd., 102A, Clive Street, Calcutta.
GHARPURE, P. V., M.D., D.T.M., & H., Major, I.M.S., Professor of Pathology, Grant Medical College, Bombay 8.
GHATAK, Narendranath, D.Sc., Chemical Examiner to Govts. of U. P. & C. P., Agra.
GHOSE, S. K., M.Sc., Geologist, Hindusthan Minerals and Natural History, Specimens Supply Co., 39, Russa Road, Tollygunj, Calcutta.
GHOSE, Sudhir Kumar, M.B., (Cal.), D.T.M., (L'pool), Chief Analyst, Calcutta Corporation, Calcutta.
GHOSH, A. K., Lecturer in Botany, University College of Science, 35, Ballygunge Circular Road, Calcutta.
GHOSH, Aghore Nath, M.B., Publicity Officer, Bengal Chemical and Pharmaceutical Works, Ltd., 164, Manicktola Main Road, Calcutta.
GHOSH, B. N., M.B.E., F.R.F.P., & S. (Glass.), L.M. (Dublin), F.R.S. (Edin.), F.S.M.F, (Bengal), Professor of Pharmacology, Carmichael Medical College, Calcutta.
GHOSH, Bidhu Bhusan, B.E., C.E., A.M.I.E., M. Amer. Soc., R.E., A.M. Amer Soc., H.V.E., Deputy Director (Civil Engineering), Department of Supply, Government of India; 165, Janak Road, Calcutta.
GHOSH, Birendra Nath, M.Sc., Lecturer in Statistics, Presidency College, Calcutta.

GHOSH, Chandra Sekhar, M.Sc., Assistant Lecturer, Department of Applied Physics University College of Science and Technology, 92, Upper Circular Road, Calcutta.

GHOSH, Dhirendra Nath, M.Sc., A.I.I.Sc., Asst. Professor of Chemistry, Science College, Patna.

GHOSH, Gopal Krishna, B.Sc., M.B., (Cal.), M.Sc., (Lond.), Head of the Department of Anatomy, P. W. Medical College, P.O. Bankipore, Patna.

GHOSH, H., M.B., (Cal.), M.S.P.E., (Paris), Consulting Bacteriologist 67, Dr. Suresh Sarkar Road, Entally, Calcutta.

GHOSH, J. M.A., (Cal.), Ph.D. (Edin,), F.N.I., Principal, Hooghly Mohsin College, Chinsura, West Bengal.

GHOSH, Sir Jnan Chandra, Kt., D.Sc., F.N.I., Director, Indian Institute of Science, Malleswaram, Bangalore.

GHOSH, K. D., M A., (Oxon.), Dip-in-Ed., Barrister-at-Law, Principal, David Hare Trainning College, Calcutta.

GHOSH, Naresh Chandra, M.Sc., Research worker, I.R.F.A., School of Tropical Medicine, Calcutta.

GHOSE, N. L., M.Sc., Ripon College, Calcutta.

GHOSH, P.K., D.Sc., Geological Survey of India, 27, Chowringhee Road, Calcutta.

GHOSH, Prashanta Kumar, M.B., D.T.M., (Cal.), T.D.D. (Wales), M.R.C.P. (Lond.), M.R.C.P. (Edin.), Senior Physician, Mayo Hospital, Calcutta; P71|, Chittaranjan Avenue Extension, Beadon Street, P.O., Calcutta.

GHOSH, S., D.Sc., Department of Applied Mathematics, University College of Science, 92, Upper Circular Road, Calcutta.

GHOSH, S. M. M.B., Asst. Professor of Medical Entomology, School of Tropical Medicine, Chittaranjan Avenue, Calcutta.

GHOSH, S. S., Asst Wood Technologist, Forest Research Institute, New Forest P.O., Dehra Dun.

GHOSH, Sudhamoy, D.Sc., F.R.I.C., M.B.E., 15, Justice Chandra Madhab Road, P.O., Elgin Road, Calcutta.

GHOSH, T. K., Manager, Messrs. B. K. Paul & Co., Ltd., 1, Bonfield Lane, Calcutta.

GHOSH, T. N., D.Sc., Bengal Immunity Research Laboratory, 153, Dharamtola Street, Calcutta.

GHURYE, Govind Sadashiv, M.A., (Bom.), Ph.D., (Cantab), Head of the Department of Sociology, University of Bombay, Khar, Bombay.

GIDEON, P. W., M.A., Professor of Biology, Karnatak College, Dharwar (Bombay Presidency).

GILL, P. S., M.Sc., Ph.D., Cosmic Ray Laboratory, Forman Christian College, Lahore.

GIRI, K. V., M.Sc. A.I.I.Sc., D.Sc., Gowthami Reader in Biochemistry, Andhra University, Waltair.

GNAMUTHU, C.P., M.A., D.Sc., Director, Zoological Research Laboratory, University of Madras, Madras.

GODBOLE, S. N. Rai Saheb, M.Sc., Dhantoli, Nagpur.

GOGATE, D. V., M.Sc., Ph.D., Professor of Physics, Baroda College, Baroda.

GOKHALE, Anant Gundo, Rao Bahadur, M.A., B.Sc., F.R.I.C., A.I.I.Sc., Superintendent, Central Distillery, Nasik Road, Bombay Presidency.

GOKHALE, Shanker Kashinath, B.A., (Hons.), M.Sc., A.I.I.Sc., Assistant Biochemist, Haffkine Institute, Parel, Bombay.

GONZALVES, (Mrs.) E., B.A., M.Sc. Lecturer in Biology, Karnatak College, Dharwar.

GOPALAKRISHNAN, A., Lecturer in Zoology College of Science, Nagpur.

GOPALAKRISHNAN, V. R., Rao Saheb, G.M.V.C., P.G., Veterinary Investigation Officer Assam, Danish Road, Panbazar, Gauhati, Assam.

GOSLNG, George W., F.R.M.S., Director, Messrs Martin & Harris, Ltd., 'Sudama House' Ballard Estate, Bombay.

*Goswami, S. K., B.E., Assistant Engineer-in-charge, C. E's Drawing Office, I & W. Directorate, Wreters' Building, Calcutta.

Greval, S. D. S., B.Sc., M.D., ch. B., D.P.H., I.M.I., Imperial Serologist & Chemical Examiner to the Govt. of India, School of Tropical Medicine Building, Calcutta.

Grigson, W. V., I.C.S., Revenue and Police Member, H.E.H., the Nizam's Government, Begumpet-Deccan.

Guha, B. C., Ph.D., (Lond.), F.N.I., Ghosh Professor of Applied Chemistry, University College Science, 92, Upper Circular Road, Calcutta.

Guha, Bhagawati Charan, D.Sc., Dept. of Physics, Presidency College, Calcutta.

Guha, P. C., D.Sc., F.N.I., Professor of Organic Chemistry, Indian Institute of Science, Malleswaram, Bangalore.

Guha, Sisir Kumar, D.Sc., Professor of Chemistry, Science College, P.O. Bankipore, Patna.

Guha-Sarkar, Sarbbani Sahay, D.Sc., D.I.C., Reader in Chemistry, Dacca University, Ramna, P.O., Dacca.

Gupta, J. C., M.B., Professor of Pharmacology, Calcutta School of Tropical Medicine, Chittaranjan Avenue, Calcutta.

Gupta, P. D., Lecturer in Zoology, University of Lucknow, Lucknow.

Gupta, S., M.Sc., Reader in Theoretical Physics, Tata Institute of Fundamental Research, 53, Pedder Road, Bombay 26.

Gupta, (Miss) S. B., B.A., B.T., (Cal.), Dip-in-Edn., (Leeds), M.Ed., (Leeds) Fellow of the Calcutta University, Inspectress of Schools, Presidency & Burdwan Divisions, Anderson House, Alipore, Calcutta.

Gupta, Subodh Chandra, M.B., (Cal.), Asst. Surgeon Superintendent, B. I. S. N. Co. Ltd., 16, Strand Road, Calcutta.

H

Hai, M. A. Khan Sahib, M.D., M.R.C.P., (Edin.), T.D.D., (Wales), Lecturer in Medicine, P. W. Medical College, Patna.

Haidar, M., M.B.E., Lt.-Col., Chairman, Department of Chemistry, Muslim University, Aligarh.

Haley, Niel James, Assistant General Superintendent (General), The Tata Iron & Steel Co., Ltd., Jamshedpur.

Hall, Kenneth, C|o. Indian Aluminium Company Limited, 5, Council House Street, Calcutta.

Hamid, K., M.Sc., D. Phil., Managing Director, Cipla Laboratories, Bombay.

Hardikar, S. W., M.D., M.R.C.P., (Edin.), Professor of Pharmacology, Osmania Medical College, Hyderabad-Deccan.

Harrison, C. J., B.Sc., O.B.E., Chief Scientific Officer, Indian Tea Association, Tocklai Experimental Station, Cinnamara P.O., Assam.

Hassan, Khwaja Habib, L.Ag., Ph.D., Government Industrial Laboratory, Narayanguda, Hyderabad, Deccan.

Hattiangadi, R. R., B.A., M.Sc., Ph.D., D.I.C., The The Associated Cement Co., Ltd., Esplanade House, Waudby Road, Fort, Bombay.

Hazra, A. K., M.B.B.S., D.T.M., Senior Bacteriologist, Haffkine Institute, Parel, Bombay 12.

Heilig, R. E., M.D., (Vienna), M.C.P., (Australia), Chief Physician, Lady Willingdon Hospital, Jaipur, Rajputana.

Hind Chemical Ltd., Manufacturing Chemist & Pharmacists, Cawnpore.

Hirachand, Lalchand, M.L.A., 'Construction House', Wittet Road, Ballard Estate, Bombay.

Hora, Sunder Lal, Rai Bahadur, D.Sc., F.L.S., F.Z.S., F.N.I., F.R.A.S.B., Director Zoological Survey of India, Jaba Kusum House, Central Avenue, Calcutta.

H. R. H., The Prince of Wales Technical School Principal, Nowgong, Assam.

HUSAIN, M. Afzal, M.A., (Cantab), M.Sc., (Panj.), F.N.I., 56, Jail Road, Forman College, P.O., Lahore.

HUSAIN, Zakir, M.A., Ph.D., Principal, Jamia Milla Islamia, Jamianagar, Delhi.

HUSSAIN, Syed, M.Sc., Ph.D., (Lond.), Head of the Department of Chemistry, Osmania University, Hyderabad, Deccan.

*HUTTON, J. H., C.I.E., M.A., D.Sc., I.C.S., F.N.I., F.R.A.S.B., University Museum of Archaeology and of Ethnology, Downing Street, Cambridge, England.

HYDER, Nizamuddeen, Khan Bahadur, Kazigarhi, P.O., Kakori, Dt., Lucknow.

I

INDIAN Veterinary Research Institute, The Director, Muktesar-Kumaun, U.P.

INDIA Meteorological Department, The Regional Director, Alipore Calcutta.

INDIAN Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.

INDIAN Central Jute Committee, 4, Hastings Street, Calcutta.

INDIAN Decimal Society, 29|1A, Baldeopara Road, Beadon Street, P.O., Calcutta.

INDIAN Science News Association, 92, Upper Circular Road, Calcutta 7.

INDIAN Sugar Mills Association, The Secretary, Security House, 102-A, Clice Street, Calcutta.

INDRA, M. K., M.Sc., Development Research Laboratory, B. O. C. Ltd., 11, Gurusaday Road, Calcutta.

INSPECTORATE of Military Explosives, Kirkee.

IRAWATHY (Miss) A. R., Lecturer, Queen Mary's College, Madras.

ISHAQUE, M., Professor of Physics, Muslim University, Aligarh.

ISRAEL, Samuel J., All-India Students' Federation, Neelum Manjil, 350, Lamington Road, Bombay 7.

IYENGAR, K. R. K., M.D., D.P.H., Lt.-Col., I.M.S., Director, Pasteur Institute of Southern India, 'Kedleston', Coonoor, Nilgiris.

IYENGAR, M. O. P., M.A., Ph.D., F.I.S., Director, University Botanay Laboratory, Triplicane, Madras.

IYER, K. Sitarama, M.A., Chalai St., Trivandrum, Travancore.

IYER, L. A. N., Rao Bahadur, Tata Professor of Geology, Patna University, Patna..

IYER, S. Rama, K.I.H., L.M. & S., Retired Civil Surgeon (Burma Service), Devarayasamudram P.O., Kolar Dist., Mysore.

J

JACOB, P. K. B.A., M.Sc., Asst. Director of Fisheries, Marine Biology, West Hill, Malabar.

JADHAV, Ganpatroa Vishramrao, B.A., (Hons.), M.Sc., Ph.D., A.I.C., Department of Chemistry, Ismail Yusuf College, P.O., Jageswari, Bombay.

JALOTA, S., 6, Kosi Road, Jamshedpur.

JATKAR, S. K. K., D.Sc., F.I.I.Sc., F.I.C., F.Inst.P., Department of Applied Chemistry, Indian Institute of Science, Malleswaram P.O., Bangalore.

JAYATUNGE, N., B.Sc. (Lond.), A.R.I.C., Assistant Government Analyst, Govt. Analyst's Laboratory, Colombo 7, Ceylon.

JENNINGS, B. R. 35, Chowringhee, Calcutta.

JHINGRAN, Anant Gopal, M.Sc., (Benares), Ph.D., (Durham), Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

JINARAJADASA, C., The Theosophical Society, Adyar, Madras.

JOB, T. J., D.Sc., Deputy Director of Fisheries, 95, Poonamalle High Road, Kilpauk, Madras.

JOIS, H. Subba, M.Sc., Professor of Organic Chemistry, Central College, Bangalore.

JONES, S., M.Sc., Research Officer, (Estuarine General), Central Inland Fisheries Research Station, 50-A, Theatre Road, Calcutta.

JOSHI, A. C., D.Sc., F.N.I., Professor of Botany, Government College, Lahore.

JOSHI, M. L., Forman Christian College, Lahore.

JOSHI, N. S., Rao Bahadur, B.E., (Civil), M.I.E., M.R.San.I., (Lond.), Executive Engineer, Nira Canals, 1287, Shivajinagar, Poona.

JOSHI, N. V., M.Sc., L.Ag., Professor of Microbiology and Biochemistry, Fergusson College, Poona 4.

JOSHI, P. N., M.Sc., (Tech.), Principal and Secretary, Victoria Jubilee Technical Institute, Matunga, Bombay.

JOSHI, S. S., D.Sc., (Lond.), University Professor and Head of the Department of Chemistry and Principal, College of Science, Benares Hindu University, Benares.

K

KALAMKAR, R. J., B.Sc., B.Ag., Ph.D. (Lond.), F.A.Sc., Deputy Director of Agriculture, Northern Circle Jubbulpur, C.P.

KALAPESI, A. S., B.Sc., D.I.C., Ph.D., (Lond.), F.G.S., F.R.G.S., Professor and Head of the Department of Geology and Geography, St., Xavier's College, Cruickshank Road, Bombay 1.

KALRE, S. M., Director, Deccan College, Post-Graduate and Research Institute, Poona 1.

KALYANSUNDARAM, V., M.A., L.T., Junior Lecturer in Geography, University of Madras, Triplicane P.O., Madras.

KANE, Govind Pandurang, M.Sc., Ph.D., (London), D.I.C., Department of Chemical Technology, Bombay University, Matunga Road, Bombay, 19.

KANGA, D. D., I.E.S., (Retd.), The Theosophical Society, Adyar, Madras.

KANJILAL, S. K., M.B.E., Director of Telegraphs (External Plant), P. & T. Directorate (Construction Branch), Eastern Court, New Delhi.

KANTEBET, S. R., M.I.R.E., A.M.I.E.E., Engineer-in-Chief, Installation and Projects, Indian Radio and Cable Communications Co. Ltd., Radio House, Bombay 1.

KAPPANNA, A. N., D.Sc., College of Science, Nagpur (C. P.).

KAR, Nisith Ranjan, M.Sc., F.G.M.S., Lecturer in Geography, Presidency College, Calcutta.

KARUNAKARAN, C. O., Public Health Laboratory, Trivandrum.

KARVE, D. D., M.Sc., Ph.D., A.I.I.Sc., Principal and Professor of Chemistry, Fergusson College, Poona 4.

KARVE, (Mrs.) Irawati, M.A., Ph.D., Reader in Sociology, Deccan College, Poona 1.

KATTI, M. C. Tummin, M.Sc., Ph.D., Chief Chemist & Works Manager, Karnatak Chemical Works, Gadag, M. & S. M. Ry.

KAUSALYA, (Miss) C. K., Lecturer in Natural Science, Queen Mary's College, Madras.

KAW, B. L., M.Sc., (Zoology), M.Sc., (Botany), L.B., Head of the Department of Biology, P. W. College, Jammu (Tawi), Kashmir.

KEHAR, N. D., M.Sc., Sc.D., Officer-in-Charge, Animal Nutrition Section, Imperial Veterinary Research Institute, Izatnagar, (U. P.).

KERAWALA, S. M., M.A., (Cantab), Senior Professor of Mathematics, Presidency College, Calcutta.

KHAN, Hamid, M.Sc., L.B. (Panj.), Ph.D., (Cantab.), F.A.Sc., Gamewardin, Punjab, 2, Sanda Soad, Lahore.

KHAN, Najib, Lt., Col., Physician in-charge and Dy. Chief Medical Officer, Tata Main Hospital, 6, Lake Road, Jamshedpur.

KHAN, Sardar, P. A. S., Asst. Botanist (Rice), Rice Farm, Kala Shah Kuka, Dist. Sheikhupura (Punjab).

KHANNA, K. L., B.Sc., (Agri.), Assoc. I.A.R.I., F.A.Sc., Sugarcane Specialist, Bihar Government, Pusa, (B.N.W. Ry.).

KHASTGIR, S. R., D.Sc., F.N.I., M.I.R.E., Head of the Department of Physics, Dacca University, Ramna, P.O., Dacca.

KHOSLA, Ajudhia Nath, Rai Bahadur, I.S.E., Consulting Engineer for Waterways, Irrigation & Navigation, and Chairman Central Waterways, Irrigation and Navigation Commission, L Block, Imperial Secretariat, New Delhi.

KIBE, M. V., M.A., M.R.A.S., Sardar, Rao Bahadur, Saraswati Niketan, Indore.

KILPADY, Sripada, M.Sc., F.G.S., Head of the Department of Geology, Nagpur University, Nagpur.

KINI, M. G., M.C., M.B., M.Ch., (Orth.), F.R.C.S., (Edin.), F.R.S.E., Superintendent, Stanley Hospital, Madras.

KISHIN, K., Statistician, Department of Agriculture, United Provinces, Lucknow.

KISHORE, Ram, B.A., A.M.I.E., (In.), Asst. Engineer, Irrigation Office, Cantonment Road, Lucknow.

KISHORE, Roop, M.Sc., Professor of Physics, Meerut College, Meerut.

KOCHAR, B. D., D.Sc., A.I.C., K.E., Medical College, Lahore.

KOLHATKAR, G. B., M.A., A.I.I.Sc., Professor of Chemistry, Fergusson College, Poona 4.

KONORIA, Gopi Krishna, Merchant and Banker, Post Box No. 7, Chowk, Patna City.

KOSAMBI, D. D., D.Sc., Tata Institute of Fundamental Research, 53, Peddar Road, Bombay 26.

KOTHARI, D. S., M.Sc., Ph.D., F.N.I., Professor of Physics and Head of the Department, University of Delhi, Delhi.

KOTWAL, Y. N., B.A., B.Sc., A.I.I.Sc., Chemist-in-Charge, Dadar Purification Works, Dadar, Bombay.

KRISHNA, M. H., M.A., D.Litt., (Lond.), Professor of History, Maharaja's College, Mysore.

KRISHNA, P. G., Agricultural Chemist, 111, Chiragali Lane, Hyderabad-Deccan.

KRISHNAN, B. T., Rao Bahadur, M.B.B.S., M.Sc., Principal and Professor of Physiology, Medical College, Mysore.

KRISHNAN, K. V., M.B.B.S., M.R.C.P., D.B., D.Sc., F.N.I., Professor of Microbiology, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

*KRISHNAN, M. S., M.A., Ph.D., A.R.C.S., D.I.C., F.N.I., Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.

KRISHNASWAMI, K. R., D.Sc., (Lond.), Industrial Chemist to Government of Bihar, Secretariat, Patna.

KRISHNASWAMY, V. D., M.A., Dip. Arch. (Cantab), Asst. Superintendent (Pre-history), Archaeological Survey of India, Southern Circle, Fort Street, Madras.

KULKARNI, G. S., M.Ag., Mycologist, Central Farm, Gwalior.

KULSHRESTHA, K. N., M.D., (Bom.), F.R.C.S., (Edin.), Physician to H. H. The Maharaja Saheb, Sayaji-ganj, Baroda.

*KUMAR, Diwan Anand, M.A., M.Sc., Reader in Zoology, Government College, Lahore.

KUMAR, L. S. S., Rao Bahadur, Economic Botanist to Government, B. P., Poona 5.

KUNDU, B. C., M.A., Ph.D., (Leeds), F.L.S., F.N.I., Director, Indian Central Jute Committee, Jute Agricultural Research Laboratory, P.O., Tejgaon, Dacca.

KUPPUSWAMI, P. S., G.M.V.C., Veterinary, Investigation Officer, Orissa, Cuttack.

KUPPUSWAMY, B., M.A., D.Litt., Lecturer in Psychology, University of Mysore, V. V. Mohalla, P.O., Mysore.

KURIYAN, George, B.A., B.Sc., Ph.D., (Lond.), Head of the Department of Geography, Madras University, Triplicane, Madras 5.

KURIYAN, George K., Research Assistant, Government Fisheries, 8, Ormes Road, Kilpauk, Madras.

KURULKAR, Ganesha Madhab, M.B.B.S., Asst. Professor of Anatomy, Seth Gordhandas Sunderdas Medical College, Bombay 28.

KUTAR, P. H., B.A., B.Sc., (Hons.), M.S., Met.E., (Edin), General Superintendent, Tata Iron & Steel Co., Ltd., Jamshedpur.

L

LACY, R. C., Professor of Botany, Science College Patna.

LAHIRI, D. C., Asst. Director, Department of Antitoxins & Sera, Haffkine Institute, Parel, Bombay 12.

LAKSHMANAN, T. K., M.A., M.Sc., L.T., Additional Professor of Physics, Presidency College, Madras 5.

LAL, Ram Bihari, M.B.B.S., D.B.H., D.T.M. & H., D.B., F.N.I., Professor of Epidemiology and Vital Statistics, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

LALL, Sohan, M.A., LL.B., B.Ed., (Edin.), Senior Psychologist, Directorate for Selection of Personnel, General Head Quarters (India), Meerut.

LAROIA, B. D., B.A., (Oxen.), Ph.D., D.I.C., (Lond.), Officer-in-Charge, Central Medical Laboratory, Old Viceregal Lodge, Delhi.

LATIF, (Lient) A., Neval Advisor to the Deputy Director of Recreeiting, 22, Davis Road, Lahore.

LATIF, Israil, M.A., Ph.D., Head of the Department of Psychology and Director, Child and Youth Guidance Clinc, Forman Christian College, Lahore.
Road, Lahore.

LAW, Nirmal Chandra, M.Sc., 50, Kailas Bose Street, Calcutta.

LAW, Satya Churn, M.A., B.L., Ph.D., F.Z.D., F.N.I., M.B.O.U., 50, Kailas Bose Street, Calcutta.

LEVI, F. W., Dr. Phill.Nat., Hardinge Professor of Mathematics, Calcutta University, Calcutta.

LIKHITE, Vishwanath Narayan, D.Sc., Deputy Director of Agriculture, "Deepak," 32, Alakapuri, Baroda.

LIMAYE, Dattatraya Balkrishna, M.A., B.Sc., Director, Ranade Industrial and Economic Institute, Deccan Gymkhana, Poona 4.

LOOMBA, Ram Murti, Lecturer in Philosophy, Lucknow University, Lucknow.

LUTHRA, Jai Chand, Rai Bahadur, I.A.S., Principal and Head of the Botanical Section, Punjab Agricultural College and Research Institute, Lyallpur, Punjab.

M

MACGREGOR, N. M., B.Sc., Senor Advisory Office, Indian Tea Association, Tocklai Experimental Station, Cinnamara P.O., Assam.

MACMILLAN, William George, Ph.D. (Cantab), F.I.C., Chief Chemist, Indian Jute Mills Association Research Institute, 16, Old Court House Street, Calcutta.

MADHAVA, K. B., M.A., A.I.A. (Lond.), F.N.I., Economist and Statisticain, War Transport Department, Govt. of India, Jamnager House, Shahjahan Road, New Delhi.

MAHABAIE, T. S., B.A., M.Sc., Ph.D., F.L.S., Assistant Editor, 'Dictionary of Economic Products and Resources of India,' Council of Scientific and Industrial Research, 20, Pusa Road, Karolbagh, New Delhi.

MAHADEVAN, C., M.A., D.Sc., F.A.Sc., F.M.G.S., F.N.I., Head of the Department of Geology, Erskine College of Natural Science, Andhra University, Waltair.

MAHAJAN, L. D., M.Sc., Ph.D., F. Inst. P. (Lond.), Professor and Head of the Physics Dept., Mahendra College, Patiala.

MAHAJAN, M. R., M.R.C.V.S. (Lond.), Deputy Director of Veterinary Services, Department of Animal Husbandry, U. P., Lucknow.

MAHALANOBIS, P. C., O.B.E., F.R.S., M.A. (Cantab), F.N.I., I.E.S., Principal and Professor of Physics, Presidency College, Calcutta.

MAHALANOBIS, S. C., F.R.S.E., I.E.S. (Retd.), Emeritus Professor of Physiology and Fellow of the University of Calcutta; 210, Cornwallis Street, Calcutta.

MAHALABIS, Sujit Kumar, M.Sc., Demonstrator of Physiology, Carmichael Medical College, Calcutta.

MAHANTI, P. C., D.Sc., F. Inst. P., F.N.I., Assoc. A.I.E.E., Dept. of Applied Physics, University College of Science, 92, Upper Circular Road, Calcutta.

MAHARASTRA, Sugar Mills Ltd., Industrial Assurance Building, opp. Churchgate Station, Fort, Bombay.

MAHENDRA, Beni Chandra, Professor of Zoology Birla College, Pilani, Jaipur State.

MAHESWARI, Panchanan, D.Sc., F.N.I., Head of the Department of Biology, Dacca University, Dacca.

MAITI, Haripada, M.A., Professor and Director of Applied Psychology, Patna University, Patna.

MAITRA, B., M.Sc., F.C.S. Director, Calcutta Chemical Co. Ltd., 35, Panditia Road, Calcutta.

*MAITRA, J. N., M.Sc., M.B., D.T.M., D.P.H. (Cal.), 1, Corries Church Lane, Amherst Street, P.O., Calcutta.

MAITRA, Susilranjan, M.Sc., Department of Physiology, University College of Science, 92, Upper Circular Road, Calcutta.

MAJEED, M. A., Professor of Zoology, Science College, Patna.

MAJUMDAR, D. N., M.A., P.R.S. (Cal.), Ph.D. (Cantab), F.R.A.I., F.N.I., Reader in Anthropology, Lucknow University, Lucknow.

MAJUMDAR, Girija Prasanna, M.Sc., Ph.D., F.N.I., Professor of Botany, Presidency College, Calcutta.

MAJUMDAR, M. S., 32-B, Mohim Haldar Street, Calcutta.

MAJUMDAR, R. C., Dr. Phil.Nat., Associate Professor of Physics, Delhi University, Delhi.

MAJUMDAR, R. C., Phill.Nat., Associate Professor of Physics, Delhi University, Delhi.

MAJUMDAR, S. K., M.Sc. (Cal.), Ph.D. (Munich.), Professor of Chemistry, Presidency College, Calcutta.

MALHOTRA, D. R., Chief Metallurgist, B.B. & C.I.Ry., Ajmere.

MALIK, A. R., Khan Bahadur, M.A., B.Sc. (Edin.), Agricultural Marketing Adviser, Government of India, The Mall, Civil Lines, New Delhi.

MALLIK, A. K., M.Sc., Meteorologist, Mateological Office, Poona 5.

MANAGER, M. P. Sugar Mills Co., Ltd., P.O. Majhaulia, R. S. Champaran.

MANDAL, Kanai Lal, D.Sc., Professor of Chemistry, City College, Calcutta.

MANGALIK, Vanmali Sharan, M.D., D.C.P., (Lond.), Reader in Pathology, King George's Medical College, Lucknow.

MANJUNATH, B. L., B.A., M.Sc. (Lond.), D.Phil. (Oxon.), Chief Editor, 'Dictionary of Echomic Products and Resources of India' 20, Pusa Road, Karol Bagh, New Delhi.

MANSINGH, Bishan, B.A., Zaminder and Farmer, The Man Bhavan, Fatehpur, U. P.

M. P. SUGAR, MILLS CO., LTD., P.O. Majha Dist. Champaran, Bihar.

MASANI, Nariman Adarji, A.M., B.Sc., Technical Chemist, Petit Mansions, Sleater Road, Bombay 7.

MASON, (Miss) Eleanor D., M.A., Ph.D., Professor of Nutrition and Physiology, Women's Christian College, P.O. Cathedral, Madras.

MATHUR, G. D., M.Sc., Statistical Research Officer, Office of the Economic Adviser, Government of India, New Delhi.

MATHUR, Har Govind Dayal, M.B., M.R.C.P.E., Dr. P.H., Professor State Medicine and Medical Officer-in-charge, Provincial Hygiene Institute, K. G. Medical College, Lucknow.

MATHUR, N. P., A.V.C., Civil Engineer, Lucknow University, Lucknow.

MATHUR, R. N., M.Sc., Assistant Entomologist, Forest Research Institute, Dehra Dun.

MATHUR, S. N., M.B.B.S., Ph.D. (Lond.), Professor of Physiology, Medical College, Lucknow.

MAZUMDER, K. C., Ph.D. (Lond.), The New control Research Laboratory, Tata Iron & Steel Co., Ltd., P.O. Tatanagar, B. N. Ry.

MEHRA, H. R., M.Sc., Ph.D. (Cantab.), Reader in Zoology, Allahabad University, Allahabad.

MEHTA, B. N., M.Sc., A.H.B.T.I., Public Health Chemist, Pratapganj, Baroda.

MEHTA, C. R., M.Sc., Ph.D., The Victoria Jubliee Technical Institute, Matunga, (G. I. P.) Bombay.

MEHTA, G. K., Research Asst., Dept. of Physics, Royal Institute of Science, Bombay.

MEHTA, J. K., B.E. (Civil), A.M.I.E. (Ind.), 7, Hill-View Road, Jamshedpur.

*MEHTA, Jivraj Narayan, M.D., (Lond.), M.R.C.P. (Lond.), L.M. & S. (Bom.), F.C.P.S. (Com.), Physician, Khambutta Hall, 16, Altamont Road, Cumbulla Hill, Bombay 26.

MEHTA, K. C., Rai Bahadur, M.Sc., Ph.D., F.N.I., Professor of Botany, Agra College, Agra, U.P.

MEHTA, K. M., M.Sc., Assoc. I.A.R.I., Public Analyst, Health Department Jodhpur.

MEHTA, (Miss) Maneck M., M.A., M.Sc., (Bom.), D.Sc., Ph.D. (Lond.), F.I.C., D.I.C., Professor of Chemistry, Queen Mary's College, Mylapore, Madras.

*MEHTA, P. I., C|o. Minerva Dyes & Chemicals Co., Inside Khanstate, opp. Pande Dharmashala, 262, Thakurdwar Road, Bombay 2.

MEHTA, S. M., B.A., M.Sc., A.I.C., Lecturer in Inorganic Chemistry, Royal Institute of Science, Mayo Road, Bombay.

MEHTA, T. H., Dy. Vice-Principal, Govt. Polytechnic, Kashmere gate, Delhi.

MENON, C. Gopal, Geologist, Associated Cement Co., Ltd., Fort, Bombay.

MENON, K. P., L.R.C.P. & S. (Edin.), 1, Viviani Road, Richards Town, Bangalore.

MENON, M. Devidas, Research Assistant, Fisheries Biological Station, West Hill P.O., S. Malabar.

MENON, T. K. N., B.A., T.D. (Leeds & Berlin), M.A.Ed. (Leeds), Principal, Secondary Teachers' Training College, Sayajiganj, Baroda.

METEOROLOGIS, T., The Superintending (Climatalogy) Meteorological Office, Poona 5.

*METRE, W. B., Geologist, B. O. C. (I. C.) Ltd., P.O. Digboi, Assam.

MILITARY Veterinary Laboratory, Lahore Cantonment.

MIRCHANDANI, T. J., M.Sc., Ph.D. (Lond.), Agricultural Chemist and Soil Physicist, Agricultural Research Station, Sakrand, Sind.

MIRCHANDANI, U. M., I.C.S., Registrar-General of Births, Deaths and Marriages, 9, Queen's Gardens, Poona.

MISRA, A. B., D.Sc., D.Phil. Head of the Department of Zoology, Benares Hindu University, Benares.

MISRA, M. L., M.A., Prof. and Head of the Dept. of Mathematics, Maharana College, Udaipur, (Rajputana).

*MISRA, Ramadhar, M.A., Ph.D. (Edin.), Reader in Mathematics, Lucknow University, Lucknow.

*MISRA, *Ramdeo*, M.Sc., Ph.D. (Lond.), Reader & Head of the Botany Dept. University of Saugar, Saugar, C. P.

MISRA, R. C., M.Sc., F.G.M.S., Lecturer in Geology, Department of Geology and Botany, Lucknow University, Lucknow.

MISTRY, S. M., M.Sc., A.I.I.Sc., 84, Sion Road, Sion, Bombay 22.

MITRA, D. R., M.A. (Edin.), Lecturer in Geography, Calcutta University, Calcutta.

MITRA, Himansu K., M.Sc., (Cal.), Ph.D., (Pittsburg), M.I.Cer.E., (U.S.A.), Refractories Engineer, Tata Iron & Steel Co., Ltd., 12-A, Road East, Jamshedpur.

MITRA, Kalidas, M.B.E., M.B., D.P.H. (Cal.), D.T.M. & H. (Eng.), F.S.S. (Lond.), Director of Nutrition, Food Department, Government of India, C|O The Rowett Nutrition Research Institute, Bucksburn, Aberdeen (Scotland).

MITRA, Ram Prasad, D.Sc., Reader in Chemistry, Delhi University, Delhi.

MITRA, S. K., M.B.E., D.Sc. (Cal. & Paris), F.N.I., Sir Rashbehary Ghose Professor of Physics, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

*MITRA, S. K., Rai Bahadur, M.Sc., Ph.D., I.A.S. (Retd.), Agricultural Adviser Eastern States Union, Balangir, Patna State.

MITRA, Suhrit Chandra, M.A., (Cal.), Dr.Phil., (Leipzib), Lecturer, Psychology Department, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

MITTER, G. C., O.B.E., M.Sc., F.I.C., Chief Assayer, His Majesty's Mint, Bombay.

MITTER, P. C., M.A., Ph.D., F.N.I., Formerly Palit Professor and Head of the Department of Chemistry, University College of Science and Technology, 22, Garpar Road, Calcutta.

MODAK, N. V., B.E., M.I.C.E., M.I.E., (Ind.), M.I.M. & Cy. E., F.R.San., I.J.P., City Engineer, Bombay Municipality Bombay.

MODI, D. F., B.Sc., Head of the Electrical Department, William Jacks & Co. Ltd., 10, Clive Street, Calcutta.

MOGHE, D. N., M.Sc., Asst. Professor of Mathematics, Ramnarain Ruia College, Mantunga, Bombay 19.

MOGHE, M. A., M.A., M.Sc., Ph.D., (Lond.), Head of the Department of Zoology, College of Science, Nagpur.

MOHAN, A. R., Associated Cement Co. Ltd., P.O., Sind Cement Works, Via-Rohri, (Sind).

MOHURY, Bipra Das, Civ. Eng., M.Soc., E.E., (France), A.M. Inst., H.E., A.I.A.E., A.M.A.E., (India), Civil Engineer, The Concrete Association of India, Victoria House, Calcutta.

MOOKERJEE, Himadri Kumar, M.Sc., (Cal.), D.I.C., D.Sc., (Lond.), F.N.I., Sir Nilratan Sircar Professor and Head of the Department of Zoology, Calcutta University, 35, Ballygunge Circular Road, Calcutta.

MOOKERJEE, K. P., M.A., B.L., 77, Asutosh Mookerjee Road, Bhowanipore, Calcutta.

MOOKERJEE, Sivatosh, B.Sc., 77, Asutosh Mookerjee Road, Calcutta.

MOONEY, H. F., C.I.E., O.B.E. I.F., Sambalpur, Orissa.

MORTIMER, Wheeler, R. E., D.Litt., Director-General of Archaeology in India, New Delhi.

MOOES, S. T., M.A., D.Sc., F.Z.S., F.R.A.I., Director of Fisheries, Baroda State, Baroda.

MOTWANI, Kewal, A.M., Ph.D., C|O. Kewalrain's Charing cross, Ootacamund.

MOUDGILL, Kishori Lal, M.A, (Cantab), D.Sc., F.I.C., Director of Research, University of Travancore, Trivandrum.

MUKHERJEE, Umadas, M.Sc., Professor and Head of the Department of Physics, College of Science, Nagpur.

*MUKERJI, B., D.Sc., M.D., F.A.Ph.S., F.N.I., Director, Central Drugs Laboratory, Government of India, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

MUKERJI, B. N., M.Sc., Ph.D., (Edin.), Lecturer in Geography, Calcutta University, Calcutta.

MUKERJI, Durgadas, M.Sc., Dept. of Zoology, University College of Science, 35, Ballygunge Circular Road, Calcutta.

MUKERJI, S. N., M.Sc., A.M.I.E., Assistant Director (Electrical), Government Test House Alipore, Calcutta.

MUKERJI, S. N., West End. Watch Co., 16, Oul Court House Street, Calcutta.

MUKERJEE, A. K., I.C.S., 38A, Lansdowne Terrace, Kalighat, Calcutta.

MUKHERJEE, Amiya Charan, M.Sc., M.B., D.T.M., Department of Anatomy, Carmichael Medical College, Calcutta.

MUKHERJEE, Bankim, M.M.F., (Bengal), L.D.S., R.C.S., (Eng.), Clinical Dental Tutor, Medical College Hospital, 3, Waterloo Street, Calcutta.

*MUKHERJEE, Bhabesh Chandra, 21, Jatin Das Road, Ballygunge, Calcutta.

MUKHERJEE, Dibakar, M.Sc., Chemist-in-Charge, Research Laboratory, Baranagore Jute Factory Co. Ltd., P.O., Alambazar, 24-Parganas.

MUKHERJEE, G. C., Professor, Engineering College, Hindu University, Benares.

MUKHERJEE, (Miss) Indira, 17|1, Harish Mookherjee Road, Bhawanipore, Calcutta.

MUKHERJEE J. N., C.B.E., D.Sc., (Lond.), F.R.A.S.B., F.C.S., F.N.I., Director, Indian Agricultural Research Institute, New Delhi.

MUKHERJEE, M. K., M.Sc., Ph.D., Post Box 10007, Calcutta.

MUKHERJEE, S., D.Sc., Division of Entomology, Indian Agricultural Research Institute, New Delhi.

MUKHERJEE, S. K., D.Sc., Lecturer in Pure Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

MUKHERJEE, S. K., M.Sc., B.L., Assistant Superintendent, H.E.H., the Nizam's Geological Survey, Jeera Compound, Secunderabad, Deccan.

MUKHERJEE, S. N., M.Sc., Professor of Physical Chemistry, College of Engineering and Technology, Bengal, P.O., Jadavpur College, 24-Parganas.

MUKHERJEE, S. S., District Engineer, B. N. Ry., B. N. Rly. House Kidderpore, Calcutta.

MUKHERJEE, Sudhamoy, M.Sc., Bengal Immunity Research Institute, 39, Lower Circular Road, Calcutta 16.

MUKHERJEE, Sardar A. T. M.Sc., Secretary, Primary & Rural Education Committee, All India Federation of Educational Associations, Nabadwip, (Bengal).

MUKHERJEE, K. C., M.A., P.R.S., 40D, Badur Bagan Street, Calcutta.

MULAY, L. N. M.Sc., Staff Quarter, Dharwar.

MULYE, Bhalchandra D., M.B., B.S., Sakkar Bazar, Indore City, Central India.

MUNDKUR, B. B., M.A., Ph.D., F.N.I. Chief Mycologist, Division of Plant Diseases, Bureau of Plant Protection & Quarartine, New Delhi.

MUNIGAVIAPPA, M., Research Fellow, Department of Mathematics, Central College, Bangalore.

MUNSI, Nihar Kumar, M.B., (Cal.), D.O.M.S., (Lond.), 55, Creek Row, Calcutta.

MURTHI, K. Narayana, M.D., Hony. Physician, Government General Hospital, P.O., Mylapore, Madras.

MURTHY, L. S., Krishna, B.Sc., Petrologist, Geological Survey, Hyderabad-Deccan.

MURTY, G. V. L. N., D.Sc., Research Chemist, Research Laboratory, Tata Iron & Steel Co., Ltd., Tatanagar.

MUTHUSWAMI, T. N., M.A., L.T., Professor of Geology, Presidency College, Madras.

MYSORE, Sugar Company Lad., Secretary, Sir Jayachamaraja Wadayar Road, Bangalore City.

N

NABAR, G. M., M.Cc., (Tech.), Ph.D., (Manch.), B.A., M.Sc., (Bom.), Department of Chemical Technology, Universiay of Bombay, Matunga, Road, Bombay 19.

NABAR, P. M., B.A., B.Sc., Tech., (Manchester), A.R.I.C., Chief Advisory Chemist, Office of the Director-General, Indian Medical Service, Imperial Secretariat, North Block, New Delhi.

NAG, N. C., M.A., F.I.C., 18|28, Dover Lane, Calcutta.

NAGAPPA, Y., M.Sc., C|o. The Burmah Oil Co., (Indian Concession), Ltd., 11, Gurusaday Road, Calcutta.

NAGAR, D. S., Asst. Cane Agriculturist, Kotai Aligarh.

NAIDU, P. S., M.A., University Reader in Education, Allahabad University, Allahabad.

NAIK, K. C., M.Sc., Fruit Specialist, Kodur, P.O., Cuddapah Dh. Madras Presidency.

NAIK, K. G., M.A., (Bom.), D.Sc., (Lond.), F.I.C., F.N.I., Principal, L.D., Arts College, Ahmedabad.

NAIK, R. N. G.B.V.C., Veterinary Investigation Officer, Bombay Presidency, Parel, Bombay.

NAIR, P. V., M.Sc., D.Phil. (Oxon.), Professor of Applied Chemistry, Central Research Institute, University of Travancore, Trevandrum.

NAIR, U. S., Ph.D., Head of the Department of Statistics, Travancore University, Trivandrum.

NANDI, B. L., M.Sc., Ph.D., D.I.G., A.I.E., 52, Shambhunath Pandit Street, Calcutta.

NANDI, Hari Kinkar M.Sc., Lecturer, Department of Statistics, Calcutta University, Calcutta.

NANDI, S. K., M.Sc., A.R.I.C., Lecturer in Chemical Engineering, Indian Institute of Science, Malleswaram P.O., Bangalore.

NARAYAN, A. L., M.A., D.Sc., F.I.P., 1, Maharani Road, Madras 18.

NARAYANA, B. T., Ph.D., Deputy Director of Agriculture, Department of Agriculture, Govt. of Mysore, Bangalore.

NARAYANA, Basudeva, M.Sc., M.B., Ph.D., F.R.S.E., Principal and Professor of Physiology P. W. Medical College, Bankipore, Patna.

†NARIMAN, R. K., A.C.H., M.I.C.E., M.Am.Soc., C.E., F.R.G.S., M.R.B.S., M.R.S.A., M.A.C., & A.E., M.E.I., (Can.), P.O. Box 13, Bombay.

NARLIKAR, V. V., B.Sc., (Bom.), B.A., (Cantab), F.R.A.S., F.N.I., Head of the Department of Mathematics, Benares Hindu University, Benares.

NARRONDAS Monordass Institute of Science, Bharatiya Vidya Bhavan, Chowpathy Road, Bombay 7.

NARWANI, C. S., M.Sc., Professor of Chemistry, D. J. Sind College, Karachi.

NATARAJAN, C. V., B.Sc., M.B., & B.S., Superintendent, Public Health Institute, Bangalore.

NATH, M. C., D.Sc., Professor & Head of the Department, of Bio-Chemistry, University of Nagpur, Nagpur.

NATH, N. S. Nagendra, M.Sc., Ph.D. (Cantab), Professor of Mathematics, Science College Patna.

NATH, Vishwa, M.Sc., Ph.D., (Cantab), F.N.I., Professor of Zoology, Government College, Lahore.

NATIONAL Scientific Supply Co., 22, Ganesh Mahal, Benares.

NAVALKAR, B. S., M.Sc., Ph.D., Assistant Lecturer in Botany, Royal Institute of Science, Bombay.

NAYAR, A. S. Mannadi, M.B.B.S., Ph.D., (Edin.), Professor of Biochemistry, Medical

NAYAR, K. Karunakaran, M.A., Ph.D., Lecturer in Zoology, University College, Trivandrum.

NAYAR, M. Raman, Lecturer in Chemistry, Lucknow University, Lucknow.

NEGI, P. S., M.Sc., Acting Entomologist, Indian Lac Research Institute, Namkum, College, Madras.
Ranchi.

NEHRU, Pandit Jawaharlal, 17, York Road, New Delhi.

NEOGI, Panchanan, M.A., Ph.D., I.E.S., (Retd.), F.N.I., 44A, New Shambazar Street, Calcutta.

NEOGY, Dhruba Lal, Chartered Marine Engineer, Assistant Port Officer, Bhaynagar, Kathiawar.

NEW, India Sugar Mills Ltd., P.O., Masanpur Sugar Mills, Dist., Darbhanga.

NIMALASURIA, Ananda, M.B.B.S., M.R.C.P., (Lond.), Medical Officer, Bhateriological Institute, Colombo, Ceylon.

NIRULA, R. L., B.Sc., Ph.D., (London), D.I.C., Head of the Department of Botany, College of Science, Nagpur.

NIYOGI, B. B., B.Sc., F.R.I.C., Lecturer in Chemistry, Indian School of Mines, Dihanbad.

NIZAM Sugar Factory Ltd., Shankarnagar, *via.* Nizamabad, Hyderabad State, Deccan.

NORTH Bengal Sugar Mills Co., Ltd., 8, Dalhousie Square East, Calcutta.

O

OBSERVATORIES, The Deputy Director-General of Climatology and Geoghysics, Poona 5.

OBSERVATORIES, The Director-General of, Lodi Road, New Delhi.

*OLPADVALA, E. S., 52, Chowringhee Road, Calcutta.

P

PAL, B. P., M.Sc., Ph.D., (Cantab), F.L.S., Imperial Economic Botanist, Indian Agricultural Research Institute, New Delhi.

PAL, Gopeswar, D.Sc., Lecturer, Department of Psychology, University College of Science, 35, Ballygunge Circular Road, Calcutta.

PAL, Srikanta Bhushan, 71, Bamacharan Chakravarti Road, P.O., Wari, Dacca.

PALIT, Santi R., 49|1A, Tallygunge Road, Kalighat P.O., Calcutta.

PANDE, S. K., D.Sc., Lecturer in Botany, Lucknow University, Lucknow.

PANDIT, C. G., M.B.B.S., Ph.D., D.P.H., D.T.M., F.N.I., Director, King Institute, Guindy P.O., Saidapet, Madras.

PANDYA, Anant H., Sc.D., (Eng.), A.M.Am.Soc.C.E., A.M.I., Struct. E., A.M.I.E., A.M., Inst.W., 12, Raja Santosh Road, Alipore, Calcutta.

PANDYA, K. C., M.A., Ph.D., D.I.C., Professor of Chemistry, St. John's College, Agra.

*PANIKKAR, N. Kesava, M.A., D.Sc., University Zoological Laboratory, Chepauk, Triplicane P.O., Madras.

PANJA, D., M.B. (Cal.), Medical Mycology Enquiry, School of Tropical Medicine, Calcutta.

PANJA, G., M.B., (Cal.), D.Bact., (Lond.), F.N.I., Professor of Bacteriology & Pathology, Calcutta School of Tropical Medicine, Calcutta.

PARAMESWARAN, H., M.A., Ph.D., D.Sc., F.Inst.P., Xanadu, Trivandrum.

PARANJPE, Gopal Ramchandra, M.Sc., A.I.I.Sc., F.N.I., J.P., I.E.S., (Retd), 'Sudarshan' 202|1, Sadasiva Road, Poona 2.

PARANJPE, (Miss) Maina M., M.Sc., Ph.D., D.I.C., Assistant Lecturer, Royal Institute of Science, Mayo Road, Bombay 1.

PARIJA, P., O.B.E., M.A., (Cantab), F.N.I., I.E.S., Vice-chancellor, Utkal University, Cuttack.

*PARKER, R. N., F.C.H., C|o. Thos. Cook & Sons., Cape Town, S. Africa.

PARIKH, H. P., M.Sc., Excise Chemist, Technological Institute, Excise Laboratory, Baroda.

PARTHASARATHY, N., B.A., B.Sc., Ph.D., (Lond.), Second Cane Breeding Officer, Indian Agricultural Research Institute, Lawley Road, Coimbatore.

*PASRICHA, B. R., M.Sc., Professor of Mathematics, I. T. College, Lucknow.

PATEL, Chaturbhai Shankarbhai, B.A., M.Sc., Ph.D., Director of Technological Institute and Industrial Chemist, Baroda State, Baroda.

PATEL, Chunibhai B., M.Sc., Technical Analyst, S. J. Science Institute, Baroda.

PATEL, J. P., C|o. The Patel Brothers, Patel House, 10, Churchgate Street, Fort, Bombay.

PATEL, J. S., Ph.D., Principal, Bihar Agriculture College, Sabour P.O., Bhagalpur.

PATEL, M. D., M.Sc., Ph.D., Director and Secretary, Institute of Agriculture, Anand.

PATEL, M. S., Ph.D., (Cantab), C|o. Mr. P. G. Bhutta, Plot No. 44A, Tilak Road, Santa Cruz, Bombay 23.

PATWARDHAN, K. A., Daly College, Indore.

PATWARDHAN, Narayan Keshava, M.Sc., Ph.D., Agricultural Chemist, College of Agricultural Research, Benares Hindu University, Benares.

PATWARDHAN, V. A., B.A., B.Sc., (Hons.), Ph.D., (Lond.), A.I.I.Sc., Professor of Chemistry, Fergusson College, Poona.

PAUL, B., B.Sc., (Glasgow), A.M.I.E.E., (Lond.), A.Amer.I.E.E., Chief Engineer, Lahore Electric Supply Co. Ltd., 51, Jail Road, Lahore.

PHALNIKAR, M. L., M.Sc., Ph.D., A.R.I.C., S. P. College, Poona 2.

PICHAMUTHU, C. S., B.S., Ph.D., (Glas.), F.R.S.E., F.G.S., F.A.Sc., F.N.I., Principal, Intermediate College, Bangalore.

PINFOLD, E. S., M.A., F.G.S., F.N.I., Geologist, C|o. Messrs. Steel Bros. & Co. Ltd., Gillanders Bildings, Clive Street, Calcutta.

PITHAWALLA, Maneck B., D.Sc., B.A., L.C.P., F.G.S., (Lond.), M.R.A.S., (Lond.), M.R.S.T., (Lond.), Bombay University Teacher of Geography for Post-Graduate Studies and Professor of Geology, N. E. D. Engineering College, Karachi.

PRABHAT, Film Co., Prabhatnagar, Poona 4.

PRAKASH, Prem, M.Sc., Physical Laboratories, Council of Scientific & Industrial Research University Bildings, Delhi.

PRAMANIK, S. K., M.Sc., (Luck.), Ph.D., (Lond.), D.I.C., Meteriological Office, Ganeshkhind Road, Poona.

PRANAVANANDA, (Rev.) Swami, (of the Holy Kailas and Manosarovar), C|o. Messrs. Laxmilal Ananda Bros., P.O., Almora, U.P.

PRASAD, B., Principal, Bihar College of Engineering, P.O., Mahendra, Patna.

PRASAD, B. N., D.Sc., (Paris), Ph.D., (L'pool), F.N.I., Reader in Mathematics, Allahabad University, Allahabad.

PRASAD, B. N., F.R.S.E., Ph.D., (Edin.), M.Sc., M.B., D.T.M., (Cal.), Professor of Pharmacology, P. W. Medical College, Bankipore, Patna.

PRASAD, Balbhadra, D.Sc., (Lond.), Professor of Chemistry, Ravenshaw College, Cuttack.

PRASAD, Mata, D.Sc., (Benares), F.N.I., Professor of Inorganic and Physical Chemistry & Principal Royal Institute of Science, Fort, Bombay.

PRASAD, S. P., Professor of Physics, Science College, Bankipore, Patna.

PRASHAD, Baini, O.B.E., D.Sc., F.R.S.E., F.L.S., F.Z.S., F.R.A.S.B., F.N.I., Fisheries Development Officer, Government of India, Department of Agriculture, New Delhi.

PUBLIC Health, Director, Holkar State.

PUNTAMBEKAR, S. V., M.Sc., Ph.D., Assistant Chemist, Forest Research Institute, DehraDun, U. P.

PUNWANI, M. G., B.A., M.B.B.S., Professor of Biology, D. J. Sind College, Karachi.

PURI, A. N., Ph.D., D.Sc., (Lond.), A.I.C., Physical Chemist, Punjab Irrigation Research Institute, Lahore.

PURI, V., D.Sc., (Agra), Head of the Biology Department, Meerut College, Meerut.

Q

QAZILBASH, Nawazish Ali, Professor of Botany, Islamia College, Peshwar.

QUDRA, M. N., Professor of Medical Chemistry, Darbhanga Medical College, P.O., Laheria Sarai, Bihar.

QURESHI, Muzaffaruddin, M.Sc., Ph.D., F.N.I., Director of Central Laboratories for Scientific & Industrial Research, Osmania University College, Hyderabad-Deccan.

R

RACINE, C. S. J., D.Sc., Professor of Mathematics, Loyola College, P.O., Cathedral, Madras.

RAGHAVAN, O. T., B.A., B.E., (Civil), A.M.I.E. (India), Executive Engineer, Water Supply, Corporation of Madras, Madras.

RAHEJA, P. C., M.Sc., (Agri.), Sugarcane Specialist, N.W.F.P., Tarnale, *via* Paleb.

RAHIMULLAH, M., D.Sc., Department of Fisheries, H. E. H. The Nizam's Government, Hyderabad-Deccan.

RAHMAN, S. A., Professor of Physiology, Osmania Medical College, Hyderabad-Deccan.

RAI, R. N., Lecturer in Physics, Delhi University, Delhi.

RAISINGHANI, G. S., B.Ag., Advocate, Agricultural Expert and Economic Planner, P.O., Halani, (Dist. Nawabshah), Sind.

**RAJ*, B. Sundara, Diwan Bahadur, M.A., Ph.D., F.N.I., Fisheries Development Officer, 1, Clive Road, Lucknow.

RAJA, K. C. K. E., Rai Bahadur, O.B.E., 2, Old Mill Road, New Delhi.

RAJAGOPAL, K., M.Sc., M.B.B.S., Major, Associate Professor of Biochemistry, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

RAJAGOPALASWAMI, Kurma, M.A., (Cantab), Geologist to the Associated Cement Companies Ltd., Esplanad House, Fort, Bombay.
Ltd., Esplanade House, Fort, Bombay.

RAJALAKSHMAN, D. V., M.A., M.Sc., Lecturer in Statistics, University of Madras, Triplicane P.O., Madras.

*RAJDERKAR, E. B., M.Sc., Industrial Physicist, Commissariat Building, Hornby Road, Bombay 1.

RAJGARHIA, Chand Mull, Giridih.

RAJNATH, M.Sc., D.I.C., Ph.D., (Lond.), F.N.I., Professor and Head of the Department of Geology, Benares Hindu University, Benares.

RAJU, S. P., B.A., B.E., M.I.E., (Ind.), Dr. Ing. (Munich), Professor of Hydraulic Engineering, Engineering College, Osmania University, Hyderabad-Deccan.

RAKSHIT, H., D.Sc., F.Inst. P., F.N.I., Lecturer in Applied Physics, University of Calcutta, Calcutta.

RAKSHIT, N. N., Chief Engineer, Tatanagar Foundry Co., Tatanagar, B. N. Ry.

RAM, Pars, Forman Christian College, Lahore.

RAM, Sahib, M.A., School of Mechanical Engineering, Roorkee.

RAMAN, G. A., Chief Chemist and Assistant Works Manager, Goodlass Wall (India), Ltd., Fergusson Road, Lower Parel, Bombay 13.

RAMANATHAN, K. R., Diwan Bahadur, M.A., D.Sc., F.N.I., Offg. Director-General of Observatories, Lodi Road, New Delhi.

RAMANATHAN, V., Deputy Director of Agriculture, Madras, P.B., 412, Triplicane P.O., Madras.

RAMANUJAM, S., M.A., Ph.D., Director, Central Potato Research Institute, New Delhi.
Research Institute, Chauliaganj, Cuttack.

RAMANUJAM, S. G. Manavala, M.A., Ph.D., D.I.C., F.Z.S., F.R.M.S., Professor of Zoology, Presidency College, Madras.

RAMASWAMI, L. S., Department of Zoology, Intermediate College, Mysore.

RAMDAS, L. A., M.A., Ph.D., F.N.I., Agricultural Meteriologist, Meteriological Office, Poona 5.

RAMIAH, K., M.B.E,. M.Sc., Dip-Agri., (Cantab), L.Ag., Director, Central Rice Research, Institute, Chauliaganj, Cuttack.

RANADE, Shridhar Balkrishna, B.A., M.Sc., Lecturer in Biology, 435, Bhagwat Bungalow, 15, Road, Khar, Bombay.

RANADE, V. V., 101, Shukarwar Peth, Poona 2.

RANJAN, Shri, M.Sc., (Cantab), Docteur-es-Sciences, F.A.Sc., Department of Botany, Allahabad University, Allahabad.

RAO, A. L. Sundara, D.Sc., Council of Scientific and Industrial Research, University Buildings, Delhi.

RAO, A. Madhava., M.Sc., Chemist, M|S. Parry and Co., Ltd., Ranipet, (S. India).

RAO, A. R. Aswatha Narayana, D.Sc., Lecturer in Colloid Chemistry, Indian Institute of Science, Bangalore.

RAO, A. Narasinga, M.A., L.T., D.Sc., F.A.Sc., Head of he Department of Mathematics and Physics, Andhra University, Waltair.

RAO, A. R. Narayana, Rao Shaib, B. E. Mech., A.M.I.E.E., Superintending Engineer, Government Electricity Department, Mettur Dam, Madras.

RAO, B. Bhujanga, M.B.B.S., N.Hy., D.T.M., & Hy. J.P., Chemical Analyser to Government, Byculla, Bombay 8.

RAO, B. Rama, M.A., D.I.C., F.G.S., F.N.I., Director, Mysore Geological Department, 'Srinibas', Visvesvarapuram, Bangalore City.

RAO, B. S. Madhava, D.Sc., Professor of Mathematics, Central College, Bangalore.

RAO, B. Sanjivia, M.A., Ph.D. (Lond.), Professor of Chemistry, Central College, Bangalore.

RAO, G. Rama, M.Sc., A.R.I.C., 65|71, Zeera, Secunderabad Dist.

RAO, G. S. Raghunath, B.Sc., M.B.B.S., D.Phil. (Oxon.), Assistant Professor of Pharmacology, University Medical College, Mysore.

RAO, I. Ramakrishna, M.A., Ph.D., D.Sc. (Lond), Department of Physics, Andhra University, Waltair.

RAO, K. Rangadhama, Professor of Physics, Andhra University, Waltair.

RAO, K. K. P. Narasinga, Asst. Staff Member of Nutrition Division Food & Agriculture organisation of the unted ruteon 200, Massachusetts Avenue, N. W., Washington 6 D. (U. S. A.).

RAO, K. Subba, D.Sc., Lecturer in Chemistry, Central College, Bangalore.

RAO, L. Narayana, M.Sc., Ph.D., (London), F.R.M.S., Professor of Botany, Central College, Bangalore.

RAO, L. Rama, M.A., F.G.S., F.A.Sc., F.N.I., Prof & Head of the Dept. of Geology, Central College, University of Mysore, Bangalore.

RAO, M. N., M.B.B.S., M.P.H.Dr.Ph., Assistant Professor of Industrial & Physiological Hygiene, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

RAO, M. V. Radhakrishna, M.B.B.S., Ph.D., Asistant Director, Haffkine Institute Bombay 12.

RAO, Mannigay Umanath, M.Sc., A.I.C., Analytical Chemist, Government Chemist P. W. D., 'Shanti Nivas', Sardarpura, Jodhpur, Rajputana.

RAO, Poona Appaji, B.Sc., Industrial Chemist, Essential Oils Chemicals, Station Road, Bhandup, Bombay, (Salearban).

RAO, P. S., B.Sc., (Eng.), M.R.S.A. (Eng.), 8|150, Aryanagar, Cawnpore.

RAO, S. Raghavender, L.M.S., (Hyd.), D.T.M., D.P.H., D.Sc. (Cal.), Epidemiologist, Public Health Department, 367, Vithalwadi, Hyderabad-Deccan.

RAO, S. Ramachandra, M.A., Ph.D., D.Sc., (Lond.), F.Inst.P., Professor of Physics, Central College, Bangalore.

RAO, V. Gopal, M.B.B.S., Pharmacology Dept., Osmania Medical College, Hyderabad.

RAO, V. L. S. Prakasa, M.A., Research Scholar, Geography Department, Calcutta University, Senate House, Calcutta.

RAO, Y. Ramchandra, Rao Bahadur, M.A., F.R.E.S., Deputy Director, Plant Protection Bureau, Dept. of Agriculture, Secretariat, New-Delhi.

RAU, A. Subba, B.A., D.Sc., F.R.M.S., Professor of Zoology, Central, College, Bangalore.

RAVALGAON Sugar Farm Ltd., Ravalgaon, Nasik, (Nasik District),

RAY, Harendranath, M.Sc., (Cal.), Ph.D. (Lond.), Protozoologist, Imperial Institute of Veterinary Research, Mukteswar, Kumaun, U. P.

RAY, J. C., M.D., Director, Indian Institute for Medical Research, P-27, Prinsep Street, Calcutta.

RAY, J. N., O.B.E., D.Sc., F.I.C., F.N.I., Director, Production of Drugs and Dressings, Office of the Director-general, Indian Medical Service, New Delhi.

RAY, Karunamay, B.Sc., (Cal), B.Sc., (Hon.), (Lond.), A.M.Inst. C.E., A.M.I., Struct. E., Chartered Civil Engineer, Resident Engineer, Hindusthan Co-operative Insurance Society, Ltd., 6-A, Surendranath Banerjee Road, Calcutta.

RAY, Priyadaranjan, M.A., F.N.I., Palit Professor and Head of the Department of Chemistry, Calcutta University College of Science and Technology, 92, Upper Circular Road, Calcutta.

RAY, R. C. D.Sc., E.I.C., F.I.I.Sc., Professor and Head of the Department of Chemistry, Science College, P.O. Bankipore, Patna.

RAY, S. B. M.B., L.M., D. G. O. 15-B, Earle Street, Calcutta.

RAY, Satyendra Nath, M.B., F. R. C. S., D. T.M. & H., Medical Practitioner, 34, Allenby Road, P.O. Elgin Road, Calcutta.

RAYCHAUDHURI, S. P., D.Sc. (Cal), D.Cc., (Lond.), F.R.I.C., Soil Survey Officer, Indian Agricultural Research Institute, New Delhi.

RAYCHAUDHURI, S. P. M.Sc., (Cal.), Assoc. I.A.R.I., Assistant Plant Pathologist, Indian Agricultural Research Institute, New Delhi.

REZACK, H. M. Abdul, Chirag Ali Road, Hyderabad-Deccan.

REDDY, B. Ranga, Joint Revenue Secretary, Nizam's Government, Bholakpur, Secunderabad (Deccan).

REDDY, D. V. Subba, M.B.B.S., Prof. of Physiology, Madura Medical College, Central Institute of Physiology, Medical College, Madras.

RICHHARIA, R. H., Ph.D. (Cantab), Economic Botanist, C|o Ram-Parikshan Roy, Esqr., Lecturer in Botany, Bihar Agricultural College, Sabour P.O., Bhagalpur, (Bihar).

RAZVI, S. M. Tahir, B.A. (Hons.) (Lond.), Ph.D. (Lond.), M.A., L.L.B., F.R.G.S., F.R.ffl.ffl., Bar-at-Law Chairman, Department of Geography, Muslim University, Aligarh.

RODE, K. P. M.Sc., Ph.D., (Zurich), Chief Geologist, Rohtas Industries, Dalmianagar, Bihar.

ROHATGI, Binay Krishna, Chemist and Industrialist, 45, Armenian Street, Calcutta.

ROHTAS Industries Ltd., Dalmianagar, (Bihar) Rly. Station, Dehri-on-Sone, E. I. Ry.

ROONWAL, M. L., M.Sc., Ph.D. (Cantab.), F.N.I., Zoological Survey of India, Kaisar Castle, Benares Cantt.

ROTHENHEIM, Carl A., 'Sea View', Worli Point, Bombay 18.

ROY, Anukul Chandra, M.Sc., Surath Cottage, Burdwan.

ROY, B., M.B. (Cal.), Lecturer in Pharmacology, Carmichael Medical College, Calcutta. Bankipore, Patna.

ROY, C. R., M.A., B.L., Curator, Victoria Museum, Karachi.

ROY, Chandra Bhusan, M.A., (Cal.), F.G.S. (Lond.), Professor of Chemistry, Science College, Bankipore, Patna.

ROY, David, M.B.E., A.C.S., Dewan, Mylliem Cherra State, Shillong, Assam.

ROY, H. L., A.B. (Harvard), Dr. Ing. (Berlin), M.I.Ch.E., Professor-in-Charge of the Chemical Engineering Department, College of Engineering and Technology, Bengal, P.O., Jadavpur College, Via Calcutta, 24-Parganas.

ROY, P. C., P.O., Salanpur, Burdwan.

ROY, Ramparikshen, Lecturer in Botany, Bihar Agricultural College, Sabour, P.O., Bihar.

ROY, S., M.Sc., Department of Applied Chemistry, University College of Science and Technology, 92, Upper Circular, Road, Calcutta.

ROY, S., Agricultural Superintendent, Cokeovens, P.O., Jamshedpur, Singhbhum.

ROY, Samarendra Nath, M.Sc., F.N.I., Lecturer, Department of Statistics, Calcutta University, Statistical Laboratory, Presidency College, Calcutta.

ROY, Santosh Kumar, Department of Geology, Presidency College, Calcutta.

ROY, Sarojendranath, M.Sc., Department of Applied Psychology, University College of Science, 92, Upper Circular Road, Calctuta.

ROY, Satyendra Prasad, Tea Planter, Post Box 59, Jalpaiguri.

ROY, Surendra Kumar, M.E.E., (Harvard), M.A.I.E.E., College of Engineering and Technology, Bengal, P.O. Jadavpur College, 24-Parganas.

ROY CHOWDHURY Tarak Chandra, Lecturer in Anthropology, University College of Science; 32|B, Allenby Road, P.O., Elgin Road, Calcutta.

ROYCHOWDHURY, K., Manufacturer of Analytical Balances, Benares Cantt.

*RUBUGUNDAY, R. K., M.A., (Cantab), Wrangler Prize Winner, Professor of Mathematics, Saugor University, 12, Saugor Cantt., King's Road. C. P.

RUDRA, J. N., Lecturer in Zoology, University College of Science, 35, Ballygunge Circular Road, Calcutta.

S

SABHARWAL, A. L., Indian Aluminium Co., Ltd., Post Box 361, 5, Council House Street, Calcutta.

SABINS, T. S., B.A., (Hon.), D.Sc., F.A.Sc., I.A.S., Principal, Agricultural College and Economic Botanist to the Government of U. P. Agricultural Gardens, Nawabganj, Cawnpore.

SADASIVAN, T. S., M.Sc., Ph.D., Director, The University Botany Laboratory, Triplicane P.O., Madras.

*SADGOPAL, M.Sc. (Tech), D.Sc., F.C.S., F.R.H.S., F.R.I.C., Department of Industrial Chemistry, College of Technology, Benares Hindu University, Benares.

SAHA, A. K., Mining Corporation Ltd., 21, Old Court House Street, Calcutta.

SAHA, Abinash Chandra, M.Sc., Professor of Physics, Bengal Educational Service, P.O., Ghoramara, Rajshahi.

SAHA, Dhirendra Kanta, B.Sc., Agent, Dacca Union Bank Ltd., 57, Clive Street, Calcutta.

SAHA, N. K., Department of Physics, University of Delhi, Delhi.

SAHA, Srish Kumar, M.Sc., Research Chemist, Bengal Chemical & Pharmaceutical Works, Ltd., 164, Maniktala Main Road, Calcutta.

*SAHANI, B. M.A., Sc.D. (Cantab), D.Sc., (London), F.R.S., Professor of Botany, Lucknow University, Lucknow.

SAKSENA, Ram Kumar, D.Sc., Reader in Botany Allahabad University, Allahabad.

SAKSENA, Shiv Dayal, M.Sc., Prof. of Botany Darbar College, Rewa C. I.

SALETORE, S. A., B.Sc., A.I.I.Sc., Ph.D., (L'pool), A.I.C. (Lond.), Professor of Chemical Technology and Director-in-Charge, Laxminarayan Institute of Technology, Nagpur University, Nagpur.

SAMADDAR, M. C., Editor, Behar Harald-and Prabhati, Kadamkuan, P.O., Patna.

SAMANTA, H., P., M.Sc., Research Chemist, Research and Control Laboratory, Tata Iron & Steel Co., Ltd., Tatanagar.

SANE, J. B., M.Sc., A.R.I.C., Textile Chemist, Khatau Mills, Byculla, Bombay.

SANKALIA, H. D., M.A., L.L.B., Ph.D., Professor and Head of the Department of History, Deccan College Post Graduate & Research Institute, Poona 1.

SANKARAN, C. R., Reader-in-Charge of Phonetics Laboratory, Deccan College Research Institute, 10, Connaught Road, Poona.

SANTAPAU, H. S. J., Ph.D., M.Sc., (Lond.), A.R.C.S., Director, Biology Department, St., Xavier's College, Fort, Bombay.

SANYAL, B. B., M.R.S.I., M.M.San.I. (Lond.), C|o. Janki Deby, 36, Kalupara Lane, P.O., Bandhaghat, Howrah.

SARABHAI, Mrinalini, C|o. Vikram A. Sarabhai, Post Box 28, Ahmedabad.

SARABHAI, Vikram A., M.A., (Cantab),Post Box 28, Ahmedabad.

SARANGDHAR, V. N., M.A., B.Sc., A.I.C., A.I.E., Town Chemist, The Tata Iron & Steel Co., Ltd., 4-D, Road East, Northern Town, Jamshedpur.

SARASWATI, Sugar Mills, Abdullapur, Ambala District.

SARBADHIKARI, P. C., D.Sc., (Lond.), Ph.D., D.I.C., F.L.S., Ghose Professor of Botany, Calcutta University, 35, Ballygunge Circular Road Calcutta.

SARGENT, John, Kt., C.I.E., M.A., D.Litt., Joint Secretary to the Government of India, Department of Education, Imperial Secretariat, New Delhi.

SARKAR, A. K., 2B, Cornfield Row, Calcutta.

SARKAR, B. K., 14|2, Bhabanath Sen Street, Calcutta.

SARKAR, Benoy Kumar, Dr. h.c., Vidyavaibha, Bengali Institute of Sociology, 82, Lansdowne Road, Calcutta.

SARKAR, Bijali Behari, D.Sc. (Edin), F.R.S.E., Lecturer in Physiology, Calcutta University, Calcutta.

SARKAR, H., 177, Upper Circular Road, Calcutta.

SARKAR, P. B., Dr-es-Sc., A.I.C., F.N.I., Ghose Professor of Chemistry, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

SARKAR, S. S., Research Fellow in Anthropology, Bose Institute, 93, Upper Circular Road, Calcutta.

SASTRI, N. S. R., Director of Statistics, Reserve Bank of India, Bombay.

SASTRY, N. S. N., M.A., Department of Psychology, Maharaja's College, Mysore.

SAVUR, S. R., M.A., Ph.D., (Lond.), Tambyacha Bungla, Colaba, Bombay.

SAWHNEY, Kalidas, Rai Bahadur, M.Sc., Director of Agriculture, Hyderabad—Deccan.

SAYEED-UD-DIN, M., M.A., (Edin.), B.Sc., F.R.M.S., Professor of Botany, Osmania University, P.O., Lallaguda, Hyderabad-Deccan.

SCHROFF, Mahadeva, L., A B., Hons. (Cornell), M.S. (Mass), 8, Royal Exchange Place Calcutta.

SCHWARZ, Anton, C|o. The Indian Standard Metal Co., Ltd., Chinchpoki Cross Lane, Bombay 27.

SCIENTIFIC Apparatus and Chemical Works Ltd., Agra, U.P.

SEAL, Srish Chandra, M.B., D.P.H., F.A., P.H.A., Asst. Professor of Epidemiology, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

SEGAL, K. N., M.B.B.S., D.PH., (Cantab), D.T.M. & H. (Lond.), M.R.S.M., Lecturer, Provincial Hygiene Institute, Lucknow.

SEKAR, C. Chandra, Professor of Statistics, All India Institute of Hygiene & Public Health, 110, Chittaranjan Avenue, Calcutta.

SEN, A., M.A., B.L., Professor, City College and Head of the Department of Studies in Political Science, Nagpur University, Nagpur,

SEN, A. B., M.Sc., Ph.D., Lecturer in Chemistry, Lucknow University, Lucknow.

SEN, Alok, M.Sc., Professor of Botany, Vidyasagar Colege, 39, Sankar Ghose Lane, Calcutta.

SEN, Anil Kumar, M.B., 45, Ballygunge Place, Calcutta.

SEN, Asoke Kumar, M.Sc., Managing Director, East India Pharmaceutical Works Ltd., 71, Russa Road, Calcutta.

SEN, B., Superintendent of Prospecting, Tata Iron & Steel Co., Jamshedpur.

SEN, B. M., M.A., I.E.S., F.N.I., Late Principal, Presidency College, Calcutta, 16, Palm Avenue, Ballygunge, Calcutta.

SEN, Basiswar, B.Sc., Director, Vivekananda Laboratory, Almora, U. P.

SEN, Bibhuti Bhusan, Professor of Mathematics, Bengal Engineering College, Shibpur, Howrah.

SEN, D. M., M.A., Ph.D., (Lond.), Secretary to the Government of India, Department of Education, New Delhi.

SEN, Dharanidhar, M.Sc., Professor and Head of the Department of Geography, Vidyasagar College, Calcutta.

SEN, G. C., Rai Bahadur, M.A., Secretary, Indian Central Jute Committee, 4, Hastings Street, Calcutta.

SEN, H. K., B.Sc., M.B., 43|3, Hazra Road, Calcutta.

SEN, Indra, M.A., Ph.D., Sri Aurobinda Assram, Pondicherry.

SEN, J. M., Rai Bahadur, M.Ed., (Leeds), B.Sc., (Cal.), T.D., (Lond.), Dip-Ed., (Oxford), F.R.G.S., F.N.I., 28, New Road, Alipore P.O., Calcutta.

SEN, J. M., M.Sc., Vice-Principal, S. D. College, Rawalpindi.

SEN, K. B., M.Sc., A.I.C., Chemist-in-Charge, Messrs. Biard & Co.'s Research Depart-Ment, Chartered Bank Buildings, Clive Street, Calcutta.

SEN, K. C., D.Sc., Director of Dairy Research, Government of India, Camp No. 1, Barakhumba Road, New Delhi.

SEN, N. N. M.Sc., A.R.S.M., Principal and Professor of Chemistry, Bengal Engineering College, P.O., Botanic Garden, Howrah.

SEN, Nalinbihari, M.Met, B.Sc., F.I.C., Chief Chemist, Tata Iron & Steel Co. Ltd., 5, Phalgu Road, Jamshedpur.

SEN, Nikhil Ranjan, D.Sc., (Cal.), Ph.D., (Berlin), F.N.I., Ghose Professor of Applied Mathematics, University College of Science and Technology, 92, Upper Circular Road, Calcutta.

SEN, Nirad Kumar, Lecturer in Botany, Presidency College, Calcutta.

SEN, Nirmal Kumar, M.A., D.Sc., Professor of Chemistry, Presidency College, Calcutta.

SEN, P. K., M.Sc., (Cal.), Ph.D., (Lond.), D.I.C., Physiological Botanist, Agricultural Research Institute, P.O., Sabour, Bihar.

SEN, Purnendu, M.Sc., Ph.D., D.I.C., Entomologist, Malaria Research Laboratory, Bengal Public Health Department, 94, Chittaranjan Avenue, Calcutta.

SEN, Ranjit Kumar, M.Sc., Research Assistant, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.

SEN, S. K., M.Sc., M.B., (Cal.), L.M., Professor of Physiology, Carmichael Medical College, 43|3, Hazra Road, Calcutta.

SEN, Satya Prasanna, M.Sc., Manager and Secretary, Bengal Chemical and Pharmaceutical Works Ltd., 164, Manicktollah Main Road, Calcutta.

SEN, Suresh Chandra, Superintendent, Cinchona Cultivation in Bengal, Mungpoo, Riyang, D. H. Rly.

SEN, Triguna, Dr. Ing. (Munich), A.M.M.E., A.M.I.E., (Lond.), Principal, College of Engineering and Technology, Bengal, P.O., Jadavpur College, via Calcutta.

SEN-GUPTA, J. C., M.Cc., (Cal.), Dr.Phil.Nat, (Heidelburg), Professor of Botany and Head of the Department, Presidency College, Calcutta.

SEN-GUPTA, (Mrs.) P. C., 41, Lansdown Terrace, P.O., Kalighat, Calcutta.

SEN-GUPTA, M., B.Sc., (Cal.), B.Sc., (Hons.), (Glas.), C.P.E., (Glas.), A.M.I.E.E., (Lond.), University Professor and Head of the Department of Electrical Engineering, Benares Hindu University, Benares.

SEN-GUPTA, N. C., D.Sc., A.R.I.C., M.Inst.Pet., Chemist-in-Charge, B. O. C., Development Research and Honorary Lecturer in Chemistry, Calcutta University, 11, Gurusaday Road, Ballygunge, Calcutta.

SEN-GUPTA, P. C., M.B., Officer-in-Charge, Kala-azar Research Department, School of Tropical Medicine, Chittaranjan Avenue, Calcutta.

SEN-GUPTA, Pratul Nath, M.Sc., A.R.I.E., Chemistry Department, University College of Science, 92, Upper Circular Road, Calcutta.

SEN-GUPTA, S. C., Assistant Post Master-General, 1, Council House Street, Calcutta.

SEN-GUPTA, Sudhir Ranjan, B.Sc., Ph.D., A.M.E.E., Assistant Educational Adviser, Education Department, Government of India, New Delhi.

SESHACHALAM, T., L.M.S., M.R.C.S., ,Eng.), L.R.C.P., (Lond.), Durbar Surgeon & Medical Officer, Victoria Hospital, Bangalore.

SESHACHAR, B. R., D.Sc., Professor of Zoology, Central College, Bangalore.

SESHADRI, T. R., M.A., Ph.D., F.I.C., Vikrama Deo Professor of Chemistry, Andhra University, Waltair.

SESHAIYA, R. V., M.A., Professor of Zoology, Annamalai University, Annamalainagar, S. India.

SETABGANJ. Agricultural Farm Ltd., P.O., Setabganj, Dinajpur.

SETH, B. R., M.A., D.Sc., (Lond.), Professor of Mathematics, Hindu College, Delhi.

SETHI, Mehr Chand, M.Sc., Professor of Botany, Forman Christian College, Lahore.

SETHNA, Suresh Mohan, Laxmi Niwas, Juhu Road, Santacruz, Bombay, 25.

SETHURAMAN, V. K., B.A., A.M.I.E., (Ind.), Assistant Electrical Engineer, Meter and Relay Tests Branch, Mettur Electric System, Mettur Dam P.O., S. I. Ry.

SETNA, S. B., Ph.D., F.R.M.S., Fisheries Officer, Department of Industries, Old Custom House, Bombay.

SHABDE, N. G., D.Sc., Principal, King Edward College, Amraoti.

SHAH, C. C., M.Sc., Ph.D., F.R.I.C., Professor of Chemistry and Head of Animal Nutrition Section, Institute of Agriculture, Anand.

SHAH, Kantilal A., M.B.B.S., Medical Officer-in-Charge, Ranchhodlal Dispensary, Panehkuwa, Ahmedabad.

SHAH, M. L., M.Sc., Ph.D., Professor, Baroda College, Baroda.

SAHA, M. S., M.Sc., (Bom.), Ph.D., (Lond.), D.I.C., Professor of Chemistry, Gujarat College, Ahmedabad.

SHAH, N. M., M.Sc., Ph.D., Department of Chemistry, Gujarat College, Ahmedabad.

SHAH, P. G., M.A., B.Cc., I.A.A.S., Lalit Kunj, 11th Road, Khar, Bombay 21.
SHAH, R. C., M.Sc., Ph.D., (Lond), A.I.I.Sc., Professor of Organic Chemistry, Royal Institute of Science, Fort, Bombay 1.
SHAH, S. M., M.A., Ph.D., (Lond.), Lecturer, Muslim University, Aligarh.
SHAH, S. S. Mahmood, M.B.B.S., P. W. Medical College, Patna.
SHAH, S. V., B.Sc., Ph.D., Professor of Chemistry, Rajaram College, Kolhapur.
SHANI, M. R., M.A., Ph.D., D.Sc., Geological Survey of India, 27, Chowringhee Road, Calcutta.
SHARIF, M., D.Sc., (Panj.), Ph.D., (Cantab), Entomologist and Plague Research Officer, Haffkine Institute, Parel, Bombay.
SHARMA, N. L., Officiating Professor of Geology, Indian School of Mines, Dhanbad.
SHARMA, P. N., D.Sc., Department of Physics, Lucknow University, Lucknow.
SHARMA, Rama Krishna, Professor of Chemistry, Sanatan Dharma College, Lahore.
SHARMA, Yajna Datta, M.A., D.Phil., (Oxon.), Assistant Superintendent, Archaeological Survey of India, Southern Circle, Fort St., George, Madras 9.
SHASTRI, N. A., King Edward College, Amraoti, Berar.
SASTRI, T. P. Bhaskara, M.A., F.R.A.S., Director, Nizamiah Observatory, Bengumpet, Hyderabad-Deccan.
SHESHADRINATHAN, N., Assistant Director, King Institute, Guindy, Madras.
SHEVADE, Shivaram Vinayak, B.Sc., Professor of Biology, Baroda College, Baroda.
SHREE, Hanuman Sugar Mills Ltd., 178, Harrison Road, Calcutta.
SRIVASTAVA, H. N., B.Sc., M.I.E.E., M.I.E., Electrical Engineer-in-Chief, Posts and Telegraphs Storeyard, Alipore, Calcutta.
SHRIVASTAVA, R. C., Agricultural Chemist, Agricultural Research Institute, Nagpur.
SHUKLA, P. D., M.A., Ph.D., Education Officer, Department of Education, Govt. of India, Simla.
SHUKLA, Soorya Narayan, M.Sc., (Luck.), Ph.D., (Lond.), A.I.C., Lecturer in Chemistry, Lucknow University, Lucknow.
SIDDIQI, Jamil Ahmad, Research Scholar, Department of Mathematics, Allahabad University, Allahabad.
SIDDIQI, M. R., Ph.D., D.Sc., F.N.I., Director, Research Institute, Osmania University, Wooden Bridge, Saifabad, Hyderabad-Deccan.
SIDDIQUI, S., D.Sc., Director, Chemical Laboratories, Council of Scientific and Industrial Research, Old Viceregal Lodge, Delhi.
SIDHU, G. S., Chemistry, Department, Lucknow University, Lucknow.
SINGH, Bawa Kartar, M.A., (Cantab), Sc.D., F.I.C., F.N.I., Hony. Professor of Chemistry and Associate Director, Punjab University Institute of Chemistry, Lahore.
SINGH, B. N., D.Sc., Lecturer in Physics, Delhi University, Delhi.
SINGH, D. R., M.A., L.T., Lt., Education Officer, Ambala Cantt.
SINGH, Dalip, M.Sc., Ph.D., (Cantab), Agricultural Chemist to Government of Punjab Lyallpur.
SINGH, Harbans, Sugarcane Specialist, Risala No. 12, Lyallpur, Punjab.
SINGH, Jagadish, M.A., Testing Officer, Civil Selection Board, Dehra Dun, U. P.
SINGH, T. C. N., D.Sc., Chief Agriculture Superintendent, Gopalpur Agricultural Farms Ltd., North Bengal Sugar Mills, Gopalpur, Rajsahi.
SINGHI, Narendra Singh, M.Sc., B.L., M.L.A., Singh Park, Ballygunge, Calcutta.
SINHA, B. N., Deputy Director of Agriculture, Chotanagpur Range, P.O., Kanka, Ranchi.
SINHA, G. P., Principal, Technical College, Dayalbagh, Agra.
SINHA, (Miss) Leela, M.A., C/o. Jamuna Prasad, Esqr., Kadamkuan (New area), Patna.
SINHA, Ramanath, M.B., 'Sunny Bank,' Chinsurah, W. Bengal.
SINHA, Suhrid Chandra, M.Sc., Department of Psychology, University College of Science, 92, Upper Circular Road, Calcutta.
SIRCAR, S. K., M.Sc., Ph.D., A.R.S.M., D.I.C., Chemical Engineer, P.O. Kusunda, Manbhum.

Sircar, S. M., M.Sc., (Cal.), Ph.D., (Lond.), D.I.C., Reader in Botany and Head of the Department of Biology, Dacca University, Dacca.

Sircar, S. N., Technical Assistant, Works Manager's Office of Tata Iron & Steel Co., Ltd., Jamshedpur.

Sircar, S. C., D.Sc., F.N.I., Lecturer in Physics, University College of Science, 92 Upper Circular Road, Calcutta.

Sitholey, R. V., Department of Botany, Lucknow University, Lucknow.

Smith, Ralph Arnot, Deputy Director of Agriculture, Chittagong Circle, Government of Bengal, Chittagong.

Sokhey, Sir S. S., Kt., M.A., D.Sc., M.D., D.T.M., & H., F.N.I., Lt.-Col., I.M.S., Director, Haffkine Institute, Parel, Bombay.

Soman, Dattatray Waman, M.B., D.P.H., D.T.M., & H., B.M.S.I., (Lond.), Research Officer, Haffkine Institute, Parel, Bombay.

Sondhi, Ved Pall, M.B.E., M.Sc., F.G.S., Geological Survey of India, 27, Chowringhee, Calcutta.

Soparkar, M. B. M.D., B.Hy., F.N.I., Research Officer, Cholera Enquiry, Indian Research Fund Association, 117, Khar, Bombay 21.

South Behar Sugar Mills Ltd., Bihta, 2t-Patna, E. I. Ry.

Srinivasan, A., M.A., D.Sc., F.I.C., Department of Chemical Technology, University of Bombay, Matunga Road, Bombay 19.

Sreenivasaiah, B. N., M.Sc., F.A.Sc., Meteorologist, Meteorological Office, P.O., St. Thomas Mount, Madras.

Srikantaiya, C., B.A., D.Sc., Professor of Chemistry, Medical College, Mysore.

Srivastava, B. N., D.Sc., Lecturer in Physics, Allahabad University, Allahabad.

Srivastava, H. D., D.Sc., Research Officer, Indian Veterniary Research Institute, Izatnagar, Bereilly.

Srivastava, L. N., M.Sc., Lecturer in Chemistry, Lucknow University, Lucknow.

Stewart, R. R., Ph.D., Gordon College, Rawalpindi.

Subramanian, T. S., Superintendent, Development Laboratory, Post Box 127, Cawnpore.

†**Subrahmanyam**, V., D.Sc., F.I.C., F.N.I., Professor of Biochemistry, Indian Institute of Science, Malleswaram, Bangalore.

Sukhatme, P. V., Ph.D., D.Sc., (Lond.), F.N.I., Statistical Adviser, Imperial Council of Agricultural Research, New Delhi.

Sundarachar, C. K., M.A., Assistant Professor of Physics, Central College, Bangalore.

Sundararajan, A. R., M.Sc., Chemist, Nutrition Research Laboratory, Coonoor.

Sur, M. M., Sur Enamel & Stamping Works Ltd., 9, Middle Road, Enttally, Calcutta.

Surma Valley Technical School, Principal, Sylhet.

Suryanarayana, D., B.A., M.Sc., Physics Department, Andhra University, Waltair.

***Swami**, Purushottama Das, M.Sc., F.I.C.S., F.G.M.S., Visharad, Department of Chemistry, Dungar College, Bikaner.

Swami, T. V., Development Minister, Government of Dungarpur, 'Retreat', Hyderabad-Deccan.

Swaminathan, B., Professor of Physics, The Maharana Bhopal College, Udaipur.

Swaroop, S., C|O. Post Master, Bareilly, U.P.

Swarup, D., Ph.D., (Shefield), A.I.E., M.I.M. M.I. & S.I., M.M.G.I., Principal, College of Mining and Metallurgy, Benares Hindu University, Benares.

T

Tagore, Pranab Nath, Businessman & Landlord, Tagore Villa, Dehra Dun.

Talwalkar, Trymbak Waman, M.S., (Illinois), Ceramist, Tata Iron & Steel Co., Ltd., 8, Bagmati Road, Jamshedpur.

Tambe, G. C., B.Ag., State Manager, Daly College, Indore, C. I.

Tare, N. B., M.Sc., (Bom.), Lecturer in Botany, Willingdon College, Sangli S. M. C., Ichalkaranji.

TAWDE, N. R., B.A., (Hon.), M.Sc., (Bom.), Ph.D., (Lond.), F.Inst.P., F.A.Sc., F.N.I., Professor of Physics, Royal Institute of Science, Mayo Road, Bombay.

TAYLOR, H. J., M.Sc., Ph.D., Professor of Physics, Wilson College, Bombay 7.

THACKER, D. D., Diwan Bahadur, M.I.M.E., F.R.S.A., (Lond.), Honorary Magistrate (First Class), Colliery Owner, Pure Jharia Colliery, (Manbhum).

THAKAR, V. M., M.Sc., Department of Organic Chemistry, Royal Institute of Science, Bombay.

THAKORE, (Miss) Kusum V., M.A., (U.S.A.), Pestonji Villa, Fatehganj, P.O., Baroda Residency.

THAKUR, B. B., B,Ag., Assistant Cotton Breeder in Sind, P.O., Agricultural College, Sakrand, Sind.

THAKUR, Ram Sinha, D.Sc., (Lond.), Ph.D., M.Sc., (Nagpur), Scientific Officer to the Master-General of Ordnance in India, M. G. O. Branch, South Block, M.G.(C)-VI, A.P.O., New Delhi.

THAKUR, S. A., C|o. Lalchand Hirachand Construction House, Wittet Road, Ballard Estate, Bombay.

THAPAR, G. S., Department of Zoology, Lucknow University, Lucknow.

THE Indian Wood Products Co. Ltd., Chemical Manufacturer, 8, Clive Street, Calcutta.

THYAGARAJAN, S., Fishery Department, Government Fishery, 8, Ormes Road, P.O., Kilpauk, Madras.

TIAGI, Greesh Kumar, M.D., (Medicine), M.D., (Pathology), Reader in Pathology and Bactereology, Medical College, Agra.

TIWARY, N. K., M.Sc., Botany Department, Benares Hindu University, Benares.

TRAVANCORE Rayons Ltd., The United Indian Life Building, Esplanade, Madras.

TRIBEDI, B. P., M.B., (Cal.), D.B., (Lond.), F.N.I., Professor of Pathology, Medical College and Bactereologist to the Government of Bengal, Calcutta.

TRIVEDI, Harbhai, President, Home School, Bhavnagar.

U

UKIL, A. C., M.B., (Cal.), M.S.P.E., (Paris), F.S.M.F.B., F.N.I., Head of the Department of Chest Diseases, Medical College Hospital, 3, Creek Row, Calcutta.

UNNY, M. Mukundan, B.Sc., (Hon.), Research Assistant, Government Fisheries, Pamban P.O., Ramnad Dist., S. India.

UPADHYAY, M. P., Fisheries Research Lebaratory, Badshabag, Lucknow.

V

*VAD, B. G., M.D., Consulting Physician, Peerbhoy Mansions, Sandhurst Road, Girgaon Bombay 4.

VAIDYA, B. K., M.Sc., Ph.D., Singhanee Lecturer in Optics, Department of Chemical Technology, Bombay University, Matunga Road, Bombay 19.

VAIDYANATHASWAMY, R., M.A., Reader in Mathematics, University of Madras, Madras.

VARMA, P. S., M.Sc., A.I.I.Sc., Professor of Organic Chemistry, Hindu University, Benares.

VARMA, R. L., I.S.E., Assistant Chief Engineer and under Secretary to the Government of Assam in the Public Works Department, Shillong, Assam.

VARMA, R. S., D.Sc., Lecturer in Mathematics, University of Lucknow, Lucknow.

VASUDEVA, R. S., Indian Agricultural Research Institute, New Delhi..

VELKAR, M.B., L.M. & S., M.L.C., 372, Thakurdwar, Bombay 2.

VENKATACHALAM, K., Orissa Medical College, Cuttack.

VENKATARAMAN, K., D.Sc., F.I.C., A.M.I.Chen.E., Mody Professor and Director of the Department of Chemical Technology, Bombay University, Matunga Road, Bombay 19.

VENKATARAMAN, R. S., B.Sc., (Hon.), Public Health Fish Officer, Government Fisheries, Madras, 8, Ormes Road, Kilpauk, Madras.

VENKATESACHAR, B., Rao Bahadur, M.A., Professor of Physics, Central College, Bangalore.

VENKATESWARAN, (Mrs.) K., Principal, Girls College, Benares Hindu University, Benares.

VENKATRAMAN, Sir T. S., Kt., C.I.E., Rao Bahadur, D.Sc., 56, Thyagaraya Road, Thyagarayanagar, Madras.

VERMA, G. S., M.Sc., Ph.D., Lecturer in Botany, University of Lucknow, Lucknow.

*VESUGAR, J., 11, Safderjang Road, New Delhi.

VIJAYARAGHAVACHARYA, Sir T., K.B.E., Diwan Bahadur, F.N.I., Late Vice-Chairman Imperial Council of Agricultural Research, Udaipur.

VIJAYARAGHAVAN, T., Staff Quarters, Andhra University, Waltair.

VISVA Bharati, Santiniketan, Bengal.

VISWANATH, B., Rao Bahadur, C.I.E., D.Sc., F.I.C., F.N.I., Professor of Agricultural Science, Benares Hindu University, Benares.

VISWANATHAN, G. R., Veterinary Investigation Officer, Madras Presidency, Vepery Post, Madras.

VISWANATHAN, P. S., Rao Sahib, Agricultural Engineer to Government of U.P., Agricultural Garden, Nawabganj, Cawnpore.

VOHRA, Pran Nath, M.Sc., Chemical Laboratories, Council of Scientific and Industrial Research, University Buildings, Delhi.

W

WADE, C. W., Capt., R.E.G.E., Soils Engineering Station, Mailtuni Camp., P.O., Asansol, Bengal.

WADIA, D. N., M.A., B.Sc., F.G.S., F.R.G.S., F.R.A.S.B., F.N.I,, Mineral Adviser, Department of Works, Mines and Power, Imperial Secretariat, North Block, New Delhi.

WADIA, (Mrs.), Meher D. N., B.A., B.T., (Bom.), C|o. Mr. D. N. Wadia, as above.

WALAWALKAR, D. G., B.Ag., M.S., Department of Sugar Chemistry, Imperial Institute of Sugar Technology, Nawabganj, Cawnpore.

WALCHANDNAGAR Industries Ltd., Walchandnagar, Poona.

†WEST, W. D., M.A., Sc.D., (Cantab), F.N.I., Director, Geological Survey of India, 27, Chowringhee, Calcutta.

Y

YADAVA, B. P., Ph.D., Lecturer in Chemistry, Lucknow University, Lucknow.

YEDDANAPALLI, Loardu M., Rev. Dr., S.I., Head of the Department of Chemistry, Loyalla College, Cathedral, P.O., Madras.

YEOLEKAR, T. G., M.A., B.Sc., Biology Department, Nowrosjee Wadia College, Poona 1.

YOUNUS, Mohd., M.A., LL.B., Ph.D., Lecturer, Department of Geography, Muslim University, Aligarh.

Z

ZAHEER, S. Hussain, B.A., (Oxon.), Ph.D., M.L.A., Reader in Chemistry, Lucknow University, Lucknow.

ZIAUD-DIN, M., M.A., Ph.D., (Wales), Head of the Department of Statistics, Punjab University, Lahore.

ZOBAIRI, R. R. K., Fisheries Research Officer, Fishdale, Ootacaniond, Nilgiris.

ZOOLOGICAL Survey of India, The Director, Kaiser Castle, Benares Cantonment.

APPENDIX

GOSHAL, S. C. M.B., D.P.H., D. Bact. (Lond.), Associate Professor, All India Institute of Hygine & Public Health, 110, Chittaranjan Avenue, Calcutta.

MULLICK, D. N., Ph.D., Animal Nutrition Section India Veterinary Research Institute, Izatnagar, Bareilly, U.P.

SRIVASTAVA, D. L., D.Sc., Central Research Institute, Kasauli (Simla Hills), East Punjab.

LIST OF FULL SESSIONS MEMBERS

A

Abdin, M. Z., Head of the Dept. of Experimental Psychology, Patna College, Patna
Agarwala, K. S., Indian Meteorological Department, Lodi Road, New Delhi.
Ahmad, F., Asst., Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
Ahmad, Nematullah Ehsan, 120, Rajendra Path, Patna.
Ahmad, Saiyid Shamin, Lecturer in Chemistry, Muslim University, Aligarh.
Ahmadali, B.Sc.,
Aiyar, H. Subramani, Principal, University College, Trivandrum.
Akhaury, B. P., B.Sc., Deputy Director of Agriculture, Bihar, Patna.
Ally, Mir Mansu, M.B., D.T.M., Assistant Professor, Dacca Medical College, Dacca.
Andrade, C. B., Imperial Chemical Industries (India) Ltd., 18, Strand Road, Calcutta.
Anwarullah, S. Ph.D., Agricultural Chemist, Bihar, Sabour.
Arya, Indra Deva Singh, Lecturer in Chemistry, College of Science, Nagpur.
Auden, J. B., Superintending Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
Awasthi, Dharani Dhar, The Herbarium, Royal Botanic Garden, Calcutta.
Aziz, Mohamed Abdul, D.Phil., Reader in Chemistry, Muslim University Aligarh.

B

Bagchi, J. J. Control Officer, Subricants Fuels Branch, Technical Div.,Estab.Laboratory, P.O. Box No. 127, Kanpur.
Bal, Capt. Chandra, M.Sc., Professor of Zoology, Benares Hindu University, Benares.
Bairathi, A. K., Statistical Officer, Jaipur State, Jaipur.
Bandyapadhyay, K. S., Central Sugar Cane Research Station, P.O., Pusa (Darbhanga), Bihar.
Banerjee, Dibendu, B.Sc., Teddington Chemical Factory, Bombay.
Banerjee, J. C., No. 30 Flat, Dairy Farm area, Kadma, Jamshedpur.
Banerjee, K. N., Rai Bahadur, M.Sc., Professor, Science College, Patna.
Banerjee, Nani Gopal, M.Sc., Statistical Laboratory, Presidency College, Calcutta.
Banerjee, Nil Ratan, C|o. Mr. V. D. Krishnamurti, The Superintendent, Archaeological Survey of India, Southern Circle, Madras 9.
Banerjee, Samiran, 9|2B, Palit Street, Ballygunge, Calcutta.
Banerji, S. M., M.Sc., M.B., Professor of Physiology, Orissa Medical College, Cuttack.
Basak, S., M.A., P28B, Lake Road, Calcutta 29.
Basu, L. M., M.Sc., Lecturer in Physics, St. Columbus College, Patna.
Basu, N. K., M.Sc., Professor of Chemistry, B. N. College, Patna.
Basu, N. K., Dept. of Pharmaceutics, Benares Hindu University, Benares.
Baweja, K. D., Ph.D., Indian Agricultural Research Institute, New Delhi.
Benawri, N. P., M.D., B.E., Professor of Physiology, Medical College, Darbhanga.
Bhaduri, B. N., Asst. Physicist, Research & Control Laboratories, Tatanagar, P.O.
Bhagwal, N. S., Electrical Engineer, C|o. Dr. P. N. Sinha, Patna.
Bhagwat, W. V., D.Sc., 54, Krishnapura, Indore City.
Bhandari, D. M., M.A., LL.B., Development Minister, Jaipur State, Jaipur.
Bhardwaj, D. C., Research Assistant, M.G.I. Scheme, Botany Dept., The University, Lucknow. ....
Bharucha, F. R., Professor of Botany, Royal Institute of Science, Bombay.
Bhat, K. S., Chief Chemist, Tatanagar Chemicals, 36D|6, Girish Mukherji Road, Bhawanipur, Calcutta.

Bhat, R. N., Metallurgist,'C|o. Kirloskar Bross Ltd., Kirloskarwadi, Dt. Satara.
Bhatia, C. M., M.A., P.E.S., Psychologist, Govt. Training College, Allahabad.
Bhatt, L. J., Lecturer in Education & Psychology, Teachers' Training College, Baroda.
Bhattacharjee, A. T., Research Laboratory, Tata Iron & Steel Co., Ltd., Tatanagar.
Bhattacharya, Charu Chandra, M.Sc., Instructor in Applied Psychology, University College of Science, 92, Upper Circular Road, Calcutta 9.
Bhattacharyya, D. K., M.Sc., Professor of Physics, Ravenshaw College, Cuttack.
Bhattacharya, S., "Ful Vue" Kadamkuan, Patna.
Bhowmik, B. B., C|o. Prof. G. P. Dube, Science College, Patna.
Bigot, Colonel A., M.D., Surgeon General with the Govt. of French India, Pondicherry.
Bose, B. B., Asst., Systematic Entomologist, Indian Agricultural Research Institute, Delhi.
Bose, (Mrs.) Chameli, M.Sc., Professor of Physics, Lady Brabourne College, Calcutta.
Bose, Kalyan, A.M.E.E., Dipl.Eng. (Murich.), Dr.Eng., 28|1|3, Gariahat Road, Ballygunge, Calcutta.
Bose, P. N., M.B., D.P.H., F.R.S.T.M. and H., Asst. Professor of Microbiology, All-India Institute of Hygiene & Public Health, 110, Chittaranjan Avenue, Calcutta.
Bose, (Mrs.), Pramila, M.Sc., Lecturer in Botany, Lady Braborne College, Calcutta.
Bose, S. K., Fuel Inspector, P304, Jotindas Road, P.O. Rashbehari Avenue, Calcutta 29.

C

Chakravarty, Makhan Lal, M.B., Ph.D., Dept. of Biochemistry, Medical College, Calcutta.
Chakravarty, R. N., M.Sc., Professor, St. Columbus College, Hazaribagh.
Chandra, G., Officer of District Loco and Carr. Supdt., Mokamahghat, (O. T. Rly.).
Chandy, (Miss.), M., Ph.D., Zoological Survey of India, Indian Museum, Kaisar Castle, Benares Cant.
Chatterjee, (Mrs.), Amita, B.Sc., B.T., Laboratory Assistant in Chemistry, Lady Brabourne College, Calcutta.
Chatterjee, B., Health Officer, Patna City Municipality, Patna.
Chatterjee, H. N., Electrical Inspector, Bihar, Patna.
Chatterjee, Jyotirmoy, M.B., 84, Russa Road South, Tallygunge, Calcutta.
Chatterjee, K. C., C|o. Bools Pure Drug Co., Ltd., Bombay 22.
Chatterji, N. M.Sc., Asst. Prof. of Mathematics, Science College, Patna.
Chattopadhaya, D. N., M.Sc., Professor of Physics, B. N. College, Patna.
Chaudhuri, R. N., M.B., M.R.C.P., T.D.D., Professor of Tropical Medicine, School of Tropical Medicine, Central Avenue, Calcutta.
Chaudhury, H. S., M.Sc., D.Phil., Professor of Zoology, Ravenshow College, Cuttack.
Chinoy, J. J., Head of the Botany Dept., University of Delhi, Delhi.
Choodamani, N. V., B.Sc., Asst. Director of Fisheries (Inland), 8, Ormes Road, Kilpauk, Madras.
Chopra, D.B., Medical College, Patna.
Chorghade, S. L., Indian Meteorological Service, Sonagaon Airfield, Nagpur.
Choudhuri, P. G., M.B., D.P.H., Statistical Officer, Directorate of Health Services, West Bengal, Calcutta.
Chowdhuri, N. K., Asst. Chemical Examineer, Govt. of India, Opium Factory, Ghazipur.
Chowla, A. N., Mining and Industries Ltd., Near Clock Tower, Bhagalpur.
Chunilal, Vaidya Pralhad, Tata Institute of Fundamental Research, Bombay 26.

D

Dambe, V. P., Principal, Pratap College, Amalne.
Das, A , M.B., M.R.C.P., Professor of Medicine, Orissa Medical College, Cuttack.
Das, A. K., D.Sc., F.N.I., Director, Solar Physics Observatory, Kodaikaunal.

Das, Anukul Chandra, M.Sc., Statistical Technician and Lecturer, Indian Statistical Institute, Presidency College, Calcutta 7.
Das, M. N., Secretary, Damodar Valley Corporation, Bee-Hive, Hazaribagh.
Das, Sudhir Ranjan, Research Fellow in Physics, Bose Institute, 93, Upper Circular Road, Calcutta 9.
Das Gupta, J. C., Ph.D., Teachers' Training Department, Calcutta University, 95, Russa Road, Calcutta.
Das Gupta, P. R., No. 1, Kabir Road, P.O., Kalighat, Calcutta 26.
Datta, D. M., Professor of Philosophy, Patna College, P.O. Mahendra, Patna. Ranchi, Bihar.
Davis, R. B., M.B., Medical Superintendent, Ranchi European Medical Hospital, Ranchi, Bihar.
Dayal, P., H.D.J. College, Agrah.
Dayal, V., M.Sc., Prof. of Chemistry, Science College, Patna.
De, Bimaleshwar, M.A., Lecturer in Experimental Psychology, Patna College, Patna.
De, B. N., Biochemical Asst., Fruit Research Station, Sabour.
De, D. C., Asst., Chief Statistician, Central Statistical Dept., Tata Iron & Steel Co., Jamshedpur.
De, H. N. Ph.D., Lecturer in Biochemistry & Officer-in-Charge, Nutrition Research Unit, I.R.F.A., Dacca University, Dacca.
De, K. L. M.Sc., District Engineer, 79, Cornowalis Street, Calcutta.
De, P. N., M.A., Professor of Mathematics, Science College, Patna.
De, Satya Prakash, Dept. of Toxins & Antitoxins, Haffkine Institute, Bombay.
De, Satyendra Nath, M.Sc., 187, Vivekananda Road, Calcutta.
Deshpande, H., Major, Chief Chemist & Metallurgist, 4, Princes Road, Jamalpur.
Desikarchary, T. V., M.Sc., Lecturer in Botany, University Botany Laboratory, Triplicane P.O., Madras.
Dessau, G., Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
Dey, N. C., M.Sc., Reader, Engineering College, Aligarh.
Dey, S. G., M.Sc., Professor of Physics, S.M.E., Kirkee.
Dey, S. C., Lecturer in Mathematics, Ceylone University, Ceylone.
Dhanbhoora, D. R., Dy. Chief Metallurgist, M|S. Tata Iron & Steel Co. Ltd., Jamshedpur.
Dhir, Mohanlal, Officer-in-Charge, Central Medical Laboratory, Ahmedabad House, Ballard Estate, Bombay 1.
Director of Administration, Ministry of Food, New Delhi.
Dixit, V. M., M.Sc., Karnatak College, Dharwar.
Dube, G. P., M.Sc., Professor of Physics, Science College, Patna.
Dutt, S. B., Head of the Dept. of Chemistry, Delhi University, Delhi.
Dutt, S., D.Sc., P.R.S., Professor of Chemistry, Delhi University, Delhi.
Dutt, S. K., M.Sc., Ex-Director, Lowa Gold Mines, 120, Ballygunge Gardens, Calcutta 19.
Dutt, W. C., M.A., Professor of Mathematics, B. N. College, Patna.
Dutta, Devavrata, Chemical Engineer, Chemical Plant & Equipment Ltd., 18|45, Dover Lane, Calcutta.
Dutta, K. K.
Dutta, (Miss) Protiva, M.A., Lecturer in Mathematics, Lady Brabourne College, Calcutta.

F

Farooq, Omar, Professor of Organic Chemistry, Muslim University, Aligarh.
Fraug, A. J., Ph.D., Fisheries Biologist to the Govt. of U. P., Lucknow.
Findlay, Alexandar, (President, Royal Institute of Chemistry), C|o. Prof. B. Sanjiva Rao, Prof. of Chemistry, Central College, Bangalore.

G

Gadre, N. B., Major, 842, Sadashiv Peth, Poona 2.
Ganapathi, K., D.Sc., F.N.I., Asst. Director, Dept. of Chemetherapy, Haffkine Institute, Bombay 12.
Gangal, D. D., M.Sc., 624, Sadashiv, Poona. 2.
Ganguly, Amalendu N., 64E, Shyampukur Street, Calcutta 4.
Ghosh, Dastidar, N. N., B.Sc., Professor of Electrical and Mechanical Engineering Bihar Engineering College, Patna.
Ghosh, J. N., M.Sc., Professor, Training College, Patna.
Ghosh, Manindra Kumar, Tata Research Laboratory, Jamshedpur.
Ghosh, P. K., Asst. Geologist, Geological Survey of India Camp., C|O Post Master, P.O. Deolapar, Nagpur, C. P.
Ghosh, R., B.Sc., A.M.W.I.. Branch Sale Manager, The Indian Oxygen & acetylene Co. Ltd., (Calcutta Branch), P. O. Alipore, Calcutta.
Ghosh, R., Superintendent, Government Press, Bihar, Patna.
Ghosh, R. N., D.Sc., F.N.I., Physics Department, Allahabad University, Allahabad.
Ghosh, Radha Gobinda, 98C, Prem Chand Baral Street, Calcutta 12.
Ghosh, Rashbehari, Geological Survey of India, 27, Chowringhee, Calcutta.
Ghosh, S. N., M.B., Head of the Dept. of Biology, B. C. P. W. Ltd., 164, Maniktola Main Road, Calcutta.
Ghosh, S. P., B.Sc., Production Officer, S. I. C., Allahabad.
Ghosh, S. K., M.A., Patna College, Patna.
Ghosh, Sachindra Nath, M.B., Patna Medical College, Patna.
Ghosh, T., M.A., Statistician, C|O The United Commercial Bank Ltd., 2, Royal Exchange Place, Calcutta.
Ghosh, Tarasankar, M.Sc., Asst. Mychologist, Jute Agricultural Research Laboratory, P.O. Tejgaon, Dacca.
Giboin, Major L., Chief Officer in Charge of the Govt. Pharmacy, Pondicherry.
Giri, Janananda, D.Sc., Ph.D., Panchbati, Ahmadabad.
Glover, P. M., Entomologist, Director, Indian Lac Research Institute, P.O. Namkum, Ranchi.
Godbole, M. Y., 20, Prithviraj Road, New Delhi.
Goenka, S. P., Bihar Cotton Mill., Phulbari, Patna.
Gohain, B. C., Asst. Anthropologist, Anthropological Survey of India, 64, Cantonment, Benares Cantt.
Gopal, Ram, Lecturer in Chemistry, Lucknow University, Lucknow.
Gorriee, R. Machagan, Rawalpindi Forest Circle, Rawalpindi (West Punjab).
Gupta, G. B., M.Sc., 8, Hariyanawala Lane, Kurla, Bombay.
Gupta, Kedarmal, Dungar College, Bikaneer.
Gupta, L., M.Sc., 84A, Narbada Road, Jubbalpur.
Gupta, M. P., M.Sc., D.Phil., Research Chemist, Tisco Research Laboratory, Tatanagar.
Gupta, R. C., Lecturer in Physics, Lucknow University, Lucknow.
Gupta, Raghunath S., M.Sc., Ph.D., Soil Chemist, Forest Research Institute, Dehra Dun.
Gupta, T. C., M.D., Lecturer in Physiology, P. W. Medical College, Patna.
Gupta, V. M., Bank Road, Patna.

H

Halder, Ragin C., B. N. College, Patna.
Hasan, Hameedul, M.Sc., Lecturer in Chemistry, Muslim University, Aligarh.
Hasib, S. A., Superintendent, Indian Mental Hospital, Ranchi.
Hoda, N., Executive Engineer, PBBEB Division, Patna.
Husain, Mahammed, B.Sc., Asst. Professor of Applied Chemistry, Science College, Patna.

I

Iyengar, R. K. N., Secretary, Road Research Planning & Advisory Committee, Council of Scientific & Industrial Research, Room No. 84A, North Block, Imperial Secretariat, New Delhi.

Iyengar, R. L. N., D.Sc., Technological Laboratory, Matunga, Bombay 19.
Iyengar, S. Ranga, Foreman, Active Acid Plant, The Mysore Iron & Steel Works, Govt. of Mysore, Bhadravati.
Iyer, B. H., Ph.D., Lecturer in Organic Chemistry, Indian Institute of Science, Bangalore.
Iyer, L. A. Krishna, Head of the Dept. of Anthropology, University Buildings, Chepauk, Madras.
Iyer, V. G., F. R. I. C., College of Mining and Metallurgy, Benares Hindu University Benares.

J

Jalota, P. L., M.Sc., Chemical Engineering Section, Indian Institute of Science, Bangalore.
Jewlikar, V. D., Director of Statistics, Commerce Dept., Gwalior Govt., Gwalior.
Jha, D. N., Cane Development Officer, Bihar, Pusa—P.O., Darbhanga.
Jogarao, A., Chemical Laboratory, Scientific & Industrial Research, University Buildings, Delhi.
Josheph, Ittyorah, C|O Dr. K. L. Moudgill, University of Travancore, Trivandrum.
Joshi, K. G., Ph.D., Biochemist to C. P. Govt., Dept. of Agriculture, Nagpur.

K

Kalbag, V. S., Royal Institute of Science, Mayo Road, Bombay.
Kamalaveni, (Miss) S., Zoological Survey of India, Indian Museum, Benares Cant.
Kanji, N. L., M.Sc., Dept. of Psychology, B. N. College, Patna.
Kapat, Gourbara, M.Sc., Instructor in Applied Psychology, University College of Science, 92, Upper Circular Road, Calcutta 9.
Kapila, M. D., Asst. Chief Metallurgist, M|S. Tata Iron & Steel Co., Ltd., Jamshedpur.
Kar, B. K., Ph.D., Professor of Botany, Kabul University, Afghanistan.
Kar, D. C., Dept. of Applied Physics, University College of Science, 92, Upper Circular Road, Calcutta 9.
Kazimi, A. A., M.A., Principal, Patna Training College, Patna.
Kelkar, G. D., Ph.D., Khatan Mukherji Spring Co., Ltd., Byalla (Bombay).
Kelkar, V. N., M.Sc., 38, Shakrawar, Poona 2.
Khaleque, J. M. H., 17, Sayed Hossain Ali Lane, P.O. Babubazar, Dacca.
Khan, M. S., Mehtab Building, New Mill Ward, Kurla, Bombay Sub Dist.
Khare, Gopal Prasad, Lecturer in Mathematics, Darban College, Rewa (C. I.).
Khatri, L. D., Deputy Director of Public Health, H. E. H. the Nizams Govt., 186-A, Chikadpalli, Hyderabad-Deccan.
Khorana, M. L., Dept. of Chemical Technology, Bombay 19.
Kothari, H. C., Statistical Officer, Jaipur State, Jaipur.
Krishnamoorthi, V., Lecturer in Applied Physics, Andhra University, Waltair.
Krishnamurthy, D. V. G., Govt. Mainfarm, Himayatsagar, Hyderabad-Deccan.
Krishnan, R. S., D.Sc., Indian Instritute of Science, Malleswaran P.O., Bangalore.
Krishnandan, J., M.Sc., Chemical Engineer, Arundalpeta, Bezwada.
Korgaokar, M. N., M.A., Professor of Mathematics, M. N. College, Visnagar, N. Gujrath, Baroda State.
Kumthekar, J. B., 296, Sadashiv, Poona 2.
Kurian, C. V., Professor of Marine Biology & Fisheries, Shankumugom, Trivandrum.
Kyaw, Hla, Professor of Biology, Rangoon University, Burma.

L

Lahiri, A., D.Sc., Asst. Director, Fuel Research Institute, Dhanbad.
Lahiri, A. N., Construction Engineer, The Tata Iron & Steel Co., Ltd., Jamshedpur.
Lal, H., I.C.S., Additional Director of Agriculture, Bihar, Patna.

Lal, K. B., Ph.D., Entomologist to the Govt., U. P., Kanpur.
Lal, Shiva Chandra, M.Sc., Professor of Mathematics, Bihar Engineering College, Patna.
Lala, Sheth Harshad, Shoodhan, Panchrati, Ellis Bridge, Ahmedabad.
Lall, A. B., Manager, The National Trading Co., Ltd., 289, Esplanade Road, Delhi.
Limaye, V. D., Forest Research Institute, Dehra Dun.

M

Malurkar, S. L., Meteorologist, Meteorological Office, Poona 5.
Mathew, N. T., M.A., Statistician, Indian Statistical Institute, Presidency College Calcutta.
Mathur, Kailash Nath, Asst. Director, Council of Scientific & Industrial Research, Imperial Secretariat (North), New Delhi.
Mazumdar, D. N., M.Sc., A.I.I.Sc., Asst. Professor of Pharmaceutics, Benares Hindu University, Benares.
Mehta, Arvind H., Zandu Pharmaceutical Works Ltd., Gokhal Road (South), P.O. Box No. 5513, Bombay 14.
Menon, I. G. K., M.B.B.S., Asst. Director, Pastur Institute, Coonoor.
Menon, M. K. K., Asst. Director, King Institute, Saidapat, Madras.
Misra, J. N., M.B.B.S., Powauri, Dist. Darbhanga.
Mishra, N., M.A., Lecturer in Philosophy, Patna College, Patna.
Misra, Narayan, Professor of Physics, Ravenshaw College, Cuttack.
Mitra, A. K., Director, Radio & Cinema Corporation, Patna.
Mitra, A. K., Ph.D., Anthoropological Survey of India, Patna.
Mitra, C. R., M.Sc., Chemical Laboratories, Council of Scientific and Industrial Research, New Delhi.
Mitra, J. N., Executive Engineer, P. W. D. Irrigation Branch, Lucknow.
Mitra, Jyotirmay, The Herbarium, Royal Botanic Garden, Calcutta.
Mitra, Prabhas Kumar, Research Scholar, Zoology Dept., Calcutta University, Calcutta.
Mondal, Sudhir Chandra, 7|1B, Mohal Lal Street, Calcutta.
Mukerji, Mrigendra Nath, Deputy Controller (Inspection), Ministry of Industries & Supplies, Govt. of India, 10, Deshapriya Park East, Calcutta 29.
Mukhapadhyay, B. K., M.Sc., Opium Chemist to Govt. of India, Ghazipur.
Mukherjee, P. N., Geological Survey of India, 27, Chowringhee, Calcutta.
Mukherjee, Amarendra Nath, Major, M.Sc., M.B., 8A, Shib Sankar Mallick Lane, Shambazar P.O., Calcutta.
Mukherjee, J. B., M.Sc., Technical Development Establishment, P.O. Box 127, Kanpur.
Mukherjee, S. P. Zandu Pharmaceutical Works Ltd., Gokhal Road (South), P.O. Box No. 5513, Bombay 14.
Mukherji, Deven, M.Sc., P.O. Mithapur, Kathiawar.
Mukherji, D. N., C|O The Hooghly Bank Ltd., Calcutta.
Mukherji, Kishori Prasad, D.T.M., Medical Practitioner, 36, Suri Lane, Calcutta.
Mulay, K. N., Manager, "Copla", Patna.
Mungavin, J. M., M.B., Imperial Chemical Industries (India) Ltd., 18, Strand Road, Calcutta.
Murty, R. S., Tata Iron & Steel Co., Ltd., Jamshedpur.
Murty, H. V. Narayan, Asst. Engineer, Patna Electrical Supply Co., Patna

N

Naeyan, A., M.Sc., Principal, Gaya College, Gaya.
Nabar, J. A., M.Sc., LL.B., Prof. of Chemistry, Wilson College, Bombay 7.
Nag, P. C., Asst. Research Officer, Indian Veterinary Research Institute, Mukteswar (U. P.).
Naik, Y. G., Ph.D., Professor of Physics, Gujarat College, Ahmedabad.

Nair, A, N. K., Statistical Officer, Ministry of Labour, Govt. of India, New Delhi.
Nair, K. K., Superintendent of Fisheries, Bengal Zoological Survey of India, Kaisar Castle, Benares Cantt.
Nair, M. P. G., Principal, Institute of Textile Technology, Trivandrum.
Nair, R. K., Director, Govt. Gardens, Trivandrum, Travancore.
Nair, R. V., Research Asst., Statistical Laboratory, Trivandrum.
Nair, T. Ramakrishna, Dept. of Biochemistry, Indian Institute of Science, Mulleswaram, Bangalore.
Nandi, H. K., Ph.D., Deputy Director of Agriculture, Orissa, Cuttack.
Nanjundappa, R. N., Lecturer in Chemical Engineering, Engineering College, Bangalore.
Narasimham, K. L., Samaldas College, Bhavnagar, Kathiawar.
Narayan, K. N., M.Sc., Lecturer in Botany, Central College, Bangalore.
Narayanamurti, D., 2, Sehlich Road, New Forest P.O., Dehra Dun.
Narayanan, E. K., 22-B, Sardar Sankar Road, Calcutta 29.
Narayanaswami, V., M.A., Botanical Survey of India, Royal Botanical Garden, Calcutta.
Nargundker, S. K., Deputy Superintendent Tata's Collieries, P.O. Jealgora, Manbhum Dist.
Natarajan, B., Ministry of Industries & Supplies, Govt. of India, New Delhi.
Nawab, S. M., Medical College, Patna.
Nepali, Rajvaidya A. N., Radiotherapist, Bhimphedi, Exchange Officer, Birgunj, P.O. Raxaul, (Dist. II. Champaran), O. T. Rly.
Niyogi, M., D.Sc., 12-B, Bepin Mitra Lane, Calcutta.
Niyogy, S. C., D.Sc., Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.

O

Ojha, Bindhyeshwari, B.Sc., Asst. Professor, Bihar Engineering College, Patna.
Ojha, K. N., Dept. of Pharmacology, Orissa Medical College, Cuttack.
Oza, T. M., Gujarat College, Ellis Bridge, Ahmedabad.

P

Pabrai, Paranjit R., Pharmacioh, Orissa Medical College, Cuttack.
Padmanabhan, S. Y., M.A., Mycologist, C.R.R.I., Cuttack.
Pande, Chandra Shekhar, M.Sc., Lecturer in Chemistry, Lucknow University, Lucknow.
Pande, Journot, 24, Park Mansions, Calcutta 16.
Pandey, K. N., M.A., Professor of Mathematics, Patna College, Patna.
Pandit, S. S., Royal Institute of Science, Mayo Road, Fort, Bombay.
Paramasivan, S., D.Sc., Asst. Archaeological Chemist in India, 36, Ganapatinagar, Tanjere (S. India).
Patel, B. M., B.Sc., Asst. Research Officer (D. T.), Institute of Agriculture, Anand.
Patel, B. V., Dept. of Pharmacology, Haffkine Institute, Bombay 12.
Patel, C. M., Professor of Biology, M. G. Science Institute, Ahemedabad.
Patel, R. P., Ph.D. (Lond.), Principal, Lallubhai Motilal College of Pharmacy, Principal's Bunglow, Ahemedabad 6.
Patel, T. D., M.B.B.S., B.M.S., Blood Bank Dept. Haffkine Institute, Bombay 12.
Pathak, P. D., Physics Dept. S. L. D. Arts College, Ahmedabad.
Phadke, (Miss) R. V., 4A, Siri Road, Malabar Hill, Bombay 6.
Philipson, A. J., C|O The Burmah Oil Co. (I. C.) Ltd., 11, Gurusaday Road, Calcutta 19.
Pillay, P. G. Nilakantia, Travancore University, Trivandrum.
Podder, V., M.Sc., Works Manager, Rohtas Industries Ltd., Dalmianagar (Bihar).
Poduval, R. V., Director of Archaeology, Trivandrum.
Poti, S. Janardan, M.A., Statistics Section, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta 12.

Prakash, Om., M.Sc., Civil Lines, Agra.
Prakash, Satya, D.Sc., Secretary, Scientific Research Committee, U. P. Govt., Allahabad.
Prakash, Satya, Science College, Patna.
Prasad, Baldeo, Extension Engineer, Indian Iron & Steel Copy., Burnpur.
Prasad, Bhubneshwar, M.A., Lecturer in Geography, Ranchi College, Patna.
Prasad, D. N., Indian School of Mines, Dhanbad.
Prasad, Hargobind, M.B., D.P.H., etc., Professor of Hygiene, P. W. Medical College, Patna.
Prasad, Harihar, Supply & Prize Control Dept., Patna.
Prasad, Jadunandan, Advocate, Patna.
Prasad, Madhavsudan, M.Sc., The New Asiatic Insurance Co. Ltd., Brojkishore Path, Patna.
Prasad, Narain, Makhanikuan, P.O. Bankipore, Patna.
Prasad, Rajendra, Asst. Professor, Old Boy's House, Benares Hindu University, Benares.
Prasad, Sheo Nath, M.Sc., B.L., Soil Biochemist, C.S.R.S., Pusa.
Prasad, Shyam Sundar, B.Pharm., Monharpatti, P.O. Nirmali, Bhagalpur.
Prasad, Vishawambhar, Patna Electrical Works, New Dak Bungalow, Patna.
Puri, B. D., Principal, Thomson Engineering College, Patna.
Purkayastham, Sujit, M.Sc., 13|1, Raja Basanta Roy Road, Calcutta 26.
Purustom, A., No. 18, Tour Road, New Forest P.O., Dehra Dun.

R

Raha, (Miss) Bibha, Women's College, Benares Hindus University, Benares.
Raizada, M. B., P.O. New Forest, Dehra Dun.
Raj, P. S. Sundara, No. 1, Olliver Road, Lucknow.
Rajagopalan, C., Lecturer in Geology, Andhra University, Waltair.
Ramamurti, K., Biochemistry Dept., Indian Institute of Science, Bangalore.
Ramanath, K. R., Lt. (L) H. M. I. S. Valerina, Jamianagar.
Ramanujam, D., Marhowrah, Saran Dist., Bihar.
Rangan, V. A. K., F.R.E.S. (Lond.), 5, Gopalakrishna Road, Thyagarayanagar P.O., Madras.
Rao, C. J. Dasa, M.S., A.R.I.C., Head of the Dept. of Technology, Andhra University, Waltair.
Rao, C. Krishnaswami, Principal, No. 3, Krishna Mahal, Bahudaji Cross Road, Bombay 19.
Rao, C. S., I.O.S., Technical Development Establishment, Sundarwala Camp, Dehra Dun.
Rao, M. Narasinga, D.Sc., Reader in Chemical Engineering, Andhra University, Waltair.
Rao, M. V. Narayana, M.A., Statistician, Indian Agricultural Research Institute, New Delhi.
Rao, P. S., D.Sc., Forest Research Institute, Dehra Dun.
Rao, R. Seshagiri, The Herbarium, Royal Botanic Garden, Calcutta.
Ratnakia, (Miss) V. R., No. 16|2, De Fouseka Place, Bambalapatiya, Colombo, Ceylon.
Ray, S. N., M.A., Professor of Philosophy & Psychology, B. N. College, Patna.
Ray, N. C., Professor, Vaidynasagar College, Calcutta.
Rege, R. D., M.Sc., Ph.D., Deputy Director of Agriculture, Govt. of Bombay, Agricultural Office, Poona.
Rohatgi, Hazari Lal M.Sc., Professor of Chemistry, D. A. V. College, Kanpur.
Rohatgi, (Miss) Krishna Kamini, M.Sc., 45, Armenian Street, Calcutta.
Roy, A. Barman, M.A., 23, Sarkar Lane, Calcutta 7.
Roy, A. C., Ph.D., Industrial Research Laboratory, Patna.
Roy, Arabinda Ph.D., 55E, Garcha Road, Calcutta 19.

Roy, A. K., Director, Regional Meteorological Centre, Alipore, Calcutta.
Roy, Jyotirmoy, M. B., D.P.H., C|O Dr. S. C. Roy, Kadam-Kuan Park, Patna.
Roy, M. B., Asst. Chemical Examiner U. P. & C. P., Agra.
Roy, Pankaj, M.Sc., Central Glass & Ceramics Research Institute, P.O. Jadavpur College, 24-Parganas.
Roy, R. K. Dutta, M.Sc., Dr. Ing., Chemist, Geological Survey of India, 27, Chowringhee, Calcutta.
Roy, S., Bhartiya Engineering Works, Sahibgung.
Roy, S. N., M.Sc., Professor of Physics, B. N. College, Patna.
Rup Rai, Tata Iron & Steel Co., Ltd., Jamshedpur.

S

Saha, G. G., A.M.Ch.E., Chemical Engineer, Chemical Engineering & Construction Co., Ltd., 29, Victoria Road, Baranagar, Calcutta.
Saha, N. C., Professor of Electrical Engineering, Annamalai University, Annamalainagar.
Sahay, H. K., B.Sc., Mechanical & Electrical Engineer, C|O. J. N. Varma, Executive Engineer, Patna Division, Patna.
Sahay, Rai Bageshwari, Ph.D., Demonstrator of Chemistry, Science College, Patna.
Sahaya, Ranjit, Special Officer, Labour Dept., Secretariat, Patna.
Sahney, T. C., Executive Engineer, Lucknow Provincial Division, The Mall, Lucknow.
Sahu, L. N., Servants of India Society, Cuttack.
Sankaran, G., All India Institute of Hygiene and Public Health, Calcutta 12.
Saran, B. K., B.A., B.L., Advocate, Patna High Court, Patna.
Saran, Nirvikar, M.Sc., 8|12, Arya Nagar, Kanpur.
Sarkar, A. N., Kadamkua, Patna.
Sarkar, Bibhutosh, Statistician, Calico Mills, Ahmedabad.
Sarkar, Sudhangshu, B.Sc., Covenanted Assistant, M|S Bird & Co., 17, Lansdowne Terrace, Calcutta 29.
Sarma, (Mrs.) Kamalmani, Geological Assistant, Geological Survey of India, 27, Chowringhee, Calcutta.
Sarup, Shanti, M.A., M.Sc., Professor of Botany, Jaswant College, Jodhpur.
Sastry, H. Srinivasa, B.A., B.E., Superintendent, Steel Foundry, The Mysore Iron & Steel Works, Government of Mysore, Bhadravati.
Sastry, V. V. K., The Eastern Technical Laboratories Ltd., 4, Blackers Road, Mount Road, Madras 2.
Satyanaraina, K. V. S., Asst, Soil Survey Officer, Indian Agricultural Research Institute, New Delhi.
Saxena, M. C., Lecturer in Physics, Lucknow University, Lucknow.
Saxena, Shiv Sahai, Professor of Zoology, Naya Bazar, Lashkar, State Gwalior.
Sen, A. C., Entomologist, to the Govt. Bihar, P.O. Sabour, Dt. Bhagalpore.
Sen, Barid Baran, M.Sc., M.B., Lecturer in Physiology, Calcutta University, Calcutta.
Sen, D. L., Director, Technological Laboratory, Matunga, Bombay 19.
Sen, D. M., D.Sc., Quinologist to the Govt. of Bengal, Mungpoo, Darjeeling.
Sen, H. M., M.B., Sen Pharmacy, New Market, Patna.
Sen, S., M.Sc., Indian Agricultural Research Institute, New Delhi.
Sen, S. B., Statistical Laboratory, Presidency College, Calcutta.
Sen, S. K., M.Sc., "Hotel Savoy", 27, Sashi Bhusan Dey Street, Calcutta.
Sen, Saurindra Nath, Dept. of Geology, Calcutta University, Geological Laboratory, Presidency College, Calcutta.
Sen Gupta, M. M., Ph.D., Professor of Physics, Science College, Patna.
Sen Gupta, N. K., A.M., Ch.E., Chemical Engineer, Chemical Engineering & Construction Co., Ltd., 20, Victoria Road, P.O. Baranagar, Calcutta.
Sen Gupta, (Miss) Phulrani, M.A., B.T., Lecturer in Geography, Lady Brabourne College, Calcutta.

Sen Gupta, S. M.A., Deputy Director, Provincial Statistical Bureau, Writer's Building, Calcutta.

Sen Gupta, S. B., D.Sc., Chief Chemist, Standar Pharmaceutical Works Ltd., 67, Dr. Suresh Sarkar Road, Calcutta 14.

Sen Gupta, Sadasiv, 90, Raja Basanta Roy Road, Kalighat P.O., Calcutta.

Sen Gupta, Satya Ranjan, Ph.D., I.G.S., Laboratory Kanpur.

Seth, T. N., Ph.D., Professor of Medical Chemistry, P. W. Medical College, Patna.

Shah, Jayasukhalal Jagamohandas, Shethpedki, Jambusal, Dt. Broach.

Sharma, A. M. Ph.D., Regional Labour Officer, Indian Sugar Syndicate Ltd., Muzaffarpur.

Sharma, Arun Kumar, The Herbarium, Royal Botanic Garden, Calcutta.

Shaw, A. K., M.Sc., Dariapore Gola, Patna.

Shaw, J. B., C|O., Dr. Monomohan Shaw, Dariapore Gola, P.O., Bankipore, Patna.

Siddappa, S., M.Sc., Asst. Professor of Chemistry, Central College, Bangalore.

Singh, Bahadur, Ph.D., Professor of Botany, B. R. College, Agra.

Singh, Dhurandhar Prasad, M.B., Dept. of Physiology, P. W. Medical College, Patna.

Singh, J., Superintendent Transportation, Dinapore, East Indian Railway.

Singh, M. K., C|O., Associated Instrument Manfrs. (India) Ltd., B-5, Clive Buildings, Calcutta.

Singh, Manik, M.B., Medical College Hospital, Patna.

Singh, Ram Kishwar Pd., M.Sc., Lecturer, Patna College, Patna.

Singh, R. N., D.Sc., Dept. of Botany, Benares Hindu University, Benares.

Singh, R. P., M.A., Lecturer, Patna College, Patna.

Singh, S. N., B.C.E., C|O., Kamleshwari Prasad, Advocate, Khazanchi Road, Patna.

Singh, Shitla Prasad, M.Sc., Dept. of Zoology, Cotton College, Gauhati.

Singh, Udita Narayan, Lecturer in Mathematics, University of Allahabad, Allahabad.

Sinha, Awadh Kishore Prasad, M.A., Lecturer in Philosophy, Patna College, Patna.

Sinha, B. N., M.Sc., Asst. Geologist, C|O The Postmaster, Srinager P.O. Dist. Ajmer Merwar.

Sinha, Basudev Narayan, Patalri Concern, P.O. Patalri, Dist. Champaran.

Sinha, Bindesri Prosad, Lecturer in Physiology, Darbhanga Medical College, Laheri-sarai (Darbhanga).

Sinha, Chandra S., M.A., C|O., The Hon'ble Mr. R. C. Sinha, Irrigation Minister, Bihar, Patna.

Sinha, G. S., M.Sc., Asst. Director of Agriculture, Separya, Saran.

Sinha, Gopalji, M.Sc., Head Master, H. E. School, Marhowrah, Saran.

Siha, M. P., Superintendent, Itki Sanatorium, Ranchi.

Sinha, N. P., B.Sc., Asst. Electrical Engineer, P.B.B.E.B. Division, Patna.

Sinha, P. C., Ph.D., Professor of Chemistry, Science College, Patna.

Sinha, P. N., M.B., B.S., P.W.Medical College, Patna.

Sinha, R. K., B.Sc., C|O., Dr. S. Sinha, Sinha Road, Patna.

Sinha, T. P., Lt. Col., M.B.B.S., R. K. Bhattacharya Road, G.P.O, Patna.

Soman, (Mrs.) Sulochana D., M.B.B.S., 91, Ranade Road Extension, Gaddel Road, Bombay 28.

Sreemulanathan, H., B.Sc., Research Scholar, Dept. of Applied Chemistry, Trivandrum.

Srinivasan, K. R., Superintendent, Archaeological Survey of India, Central Circle, Patna.

Srinivasan, N. R., M.Sc., General Chemistry Dept., Indian Institute of Science, Malleswaran P.O., Bengalore 3.

Subrahmanyam, D. L., M.Sc., Research Assistant, Indian Institute of Science, Bangalore.

Subramanyam, K., M.Sc., 55, Cross Road, Silk Farm Extension, Basarangudy P.O., Bangalore.

Subrahmanyam, K., M.A., Asst. Professor of Biochemistry, Orissa Medical College, Cuttack.

Subrahmanyan, K., All India Institute of Hygiene & Public Health, 110, Chittaranjan Avenue, Calcutta 12.

Sud, Baldev Chand, M.Sc., Chief Development Research Chemist, M|S Shalimar Tar Products, Jharia.

Sukhatme, A. V., Chief Statistician, Central Statistical Dept., Tata Iron & Steel Co., Jamshedpur.

Sundararao, W. V. B., Ph.D., Soil Chemist, Indian Agricultural Research Institute, New Delhi.

Swami, Achintyananda, Ram Krishna Mission, Patna.

T

Talapatra, S. K., Ph.D., Physiological Chemist, Cattle Nutrition Scheme, Assam.

Talwar, V. D., Managing Director, The Punjab Iron & Electrical Works, Aishbagh, Lucknow.

Tamhane, R. K., Ph.D., Soil Survey Officer, Indian Agricultural Research Institute, New Delhi.

Tandan, R. K., I.O.S., Technical Development Establishment, Sundarwala Camp, Dehra Dun.

Tapadar, Dinesh Ch., M.Sc., Chief Chemist, Indian Paper Pulp Co., P.O., Hazinagar, Naihati, 24, Parganas.

Tata Oil Mills Co., Ltd., Tatapuram P.O., Cochin State.

Thein, U. Tun, Vice President, Council of Burma Industries, 128|132, Phayre Street, Rangoon, Burma.

Tiwari, Krishna Kant, M.Sc., Asst. Zoologist, Zoological Survey of India, Kaisar Castle, Benares Cantt.

Trivedi, A. M., Professor of Chemistry, L. D. College, M. G. Science Institute, Ahmedabad.

Tun, U. Saw, Superintendent of Industries, Rangoon, Burma.

V

Vaidyam Jugatram S., Zandu Pharmaceutical Works, Ltd., Gokhale Road (South), P.O., Box No. 5513, Bombay 14.

Varma, B. P., Industrial Chemist, Gangalay, Kadamkuan, Patna.

Vasudev, N. M., M.Sc., D|34, Ganesh Baug, 208, Vincent Road, Matunga, Bombay 19.

Venkataramadeo, T., Ph.D., Reader in Mathematical Physics, Andhra University, Waltair.

Venkataramanan, K., M.Sc., Dept. of Biochemistry, Indian Institute of Science, Malleswaran P.O., Bangalore.

Venkateswaran, C. S., Professor of Physics, University College, Trivandrum.

Venkiteshwaran, S. P., Meteorologist in Charge, Instruments & Supplies, Weather Office, Poona 5.

Veeraraghavan, N., D.Sc., Director, Pasteur Institute, Coonoor.

Verma, R. P., B.Sc., Asst Biochemist, Dept. of Agriculture, Bihar.

Verma, S. R., Chemical Pathologist, Medical College, Patna.

Vidyarthi, N. L., Provincial Industrial Research Laboratory, Bihar, Patna.

Vijayaraghavan, Sri C., Millet Specialist, Agricultural College and Research Institute, P.O. Lawley Road, Coimbatore.

Viswanathan, S. Asst. Chief Meetallugist (Rech.), The Tata Iron & SsCsl Co., Ltd. Tatanagar.

Vyar, V. A., M.Sc., Head of the Chemistry Dept., Dharmendrasinji College, Rajkot, Kathiawar.

W

Wadnhekar, S. V., Electrical Engineer, C|O Dr. P. N. Sinha, Patna.
Whitaker, J. W., Director, Fuel Research Institute, Dhanbad.

Y

Yodh, G., 18, Darabsha Road, Bombay 26.

LIST OF ASSOCIATE MEMBERS

A

Achari, (Mrs.) P. A., Trichur, Cochin State.
Adhan, (Miss) S., M. A., Warden' Bunglow, Patna College, Patna.
Agarwal, R. P., Lecturer in Mathematics, Lucknow University, Lucknow.
Agarwal, S. C., M.Sc., Lecturer in Botany, Lucknow University, Lucknow.
Agrawal, I. P., M.A., Animal Nutrition Section, Indian Veterinary Research Institute, Izatnagar.

Agrawal, P. L., B.Sc., Asst. Professor of Metallurgy, College of Mining and Metallurgy, Benares Hindu University, Benares.

Ahmad, Z., Patna.
Ali, S. L., Patna City.
Amarendra, M. C., C|O The Patna Electric Supply Co., Patna.
Amma, P. Narayani, C|O P. A. Achari, Esqr., Trichur, Cochin State.

B

Baksi, Sukumar, Kadamkuan, Patna.
Bandyapadhyay, Gaganbihari, M.Sc., Research Scholar, Dept. of Applied Mathematics, University College of Science, 92, Upper Circular Road, Calcutta.

Banerjee, Anadi Nath, Deputy Superintendent of Education, Kashmere Gate, Delhi.
Banerjee, A. K., M.Sc., Govind Mitter Road, Patna.
Banerjee, H. K., Advocate, High Court, Patna.
Banerjee, J. C., Lecturer in Chemistry, B. N. College, Patna.
Banerjee, Kalidas, M.Sc., C|O Banerjee & Sons, Station Road, Patna.
Banerjee, Lokendra Nath, Congress Maidan, Kadamkuan, Patna.
Banerjee, S. K., 193, Sibpur Road, P.O. Sibpore, Howrah.
Banerjee, S. K., B.Sc., C|O Dr. T. N. Banerjee, Patna.
Barat, A. K., P. W. Medical College, Patna.
Basak, M.
Basak, N. G., Chemistry Dept., Indian Institute of Science, Malleswaram P.O. Bangalore.
Basu, Biman Behari, M.A., Bettiah Words Estate, Bettiah.
Basu, Gauri Sankar, C|O Dr. A. C. Roy, Kadamkuan, Patna.
Behari, Bepin, Institute of Psychological Research Service, Patna University, Patna.
Bhadbhade, K. H., Major, I.A.M.C., 58, Services Selection Road, Bareilly.
Bhagat, Kinity Bhusan, M.Sc., C|O Mr. A. K. Sarkar, Kadamkuan, Patna.
Bhattacharjee, (Miss) Usha, Post Graduate Girls' Hostal, 56, Harrison Road, Calcutta 9.
Bhattacharya, S., B.Sc., Bengal Immunity Research Laboratory, 153, Dharmatolla Street, Calcutta.

Baattacharyya, Bhabani, Medical College, Patna.
Bhattacharyya, Ganganath, M.A., Professor, Patna College, Patna.
Bhattacharyya, N. P., M.Sc., C|O Prof. S. N. Bhattacharyya, M.A., Dariapur, Patna.
Bhattacharyya, Paresh Nath, M.A., Dept. of Psychology, Calcutta University, Calcutta.
Bose, S., Anisabad, Patna.
Brahma, (Mrs.) Binamani, C|O Mr. J. C. Brahma, Dak Bungalow Road, Patna.
Brahmachari, H. D., M.Sc., Biochemistry Dept. L. I. T. Buildings, Nagpur.

C

Chakraborty, K. N., Medical Asst., Institute of Psychological Service, Dept. of Psychology, Patna University, Patna.
Chakravarty, Bholanath, M.Sc., G. B. B. College, Muzaffarpur.
Chakravarty, B., Dinapore.
Chakravarty, N., M.B., Asst. Research Workers, Dept. of Tropical Medicine, School of Tropical Medicine, Calcutta.
Chand, Prithvi, M.Sc., Research Scholar, Indian Veterinary Research Institute, Izatnagar, Bareilly.
Chanda, Bimal, Chemical Engineer.
Chandra, J., Dinapore Cantt, Patna.
Chandra, S. K., Chandra Brothers, Patna.
Chatterjee, Anil Chandra, Curex Laboratories (India) Ltd., 204|1, Russa Road South, Tallygunge, Calcutta.
Chatterjee, A. K., M.Sc., Lecturer in Chemistry, B. N. College, Patna.
*Chatterjee, Aparesh, Demonstrator in Physics, University College of Science, 92, Upper Circular Road, Calcutta 9.
Chatterjee, D., Nalanda College, Patna.
Chatterjee, (Miss) Monica, Dakbanglow Road, Patna.
Chatterjee, S. K., M.Sc., Chemist, Tisco. Jamshedpur.
Chatterjee, Anunoy, C|O Mr. Tej Chandra Chatterjee, P.O. Mahendra, Patna.
Chaudhuri, Sachindranath, M.B., 5, Mahes Chaudhuri Lane, Bhowanipur, Calcutta.
Chaudhury, S., M.Sc., Bengal Immunity Research Laboratory, 153, Dharamtolla Street, Calcutta.
Chauhan, J. H., Ranchi.
Cohen, (Miss) Florie, Post Graduate Girls' Hostel, 56, Harrison Road, Calcutta 9.
Cooper, M. M., 35, Arathron Road, Rayapuram, Madras.

D

Das, J., A. A. H. Course, Indian Veterinary Research Institute, Izatnagar (Bareilly).
Das, Prasanna Kumar, Lecturer in Chemistry, Ravenshaw College, Cuttack.
Das Gupta, A. C., 29A, Satish Mukherjee Road, Calcutta 26.
Devi, (Miss) Parvati, C|O Shree Bindeshwari Prasad, New Area, Kadamkuan, Patna.
Dhar, Dharani, Patna College, Patna.
Dutta, Bijoya, P. M. C. H.
Dutta, Phani Bhushan, M.Sc., Bose Research Institute, 93, Upper Circular Road, Calcutta.

G

Gadre, K. M., C|O Director, Agricultural Meteorology, Meteorological Office, Poona 5.
Ganguli, Anil Kumar, M.Sc., Dept. of Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.
Ganguli, H. D., Asst. Chemical Examiner of the Govt. of West Bengal, Medical College, Calcutta 12.
Ganguly, Diptendu, M.Sc, 11|4, Mukherjee Para Lane, P.O. Dhakuria, Calcutta.
Ganguly, S. K., M.Sc., Bengal Immunity Research Laboratory, 153, Dharamtolla Street, Calcutta.
Ghatak, S. N., Research Assistant, H. B. Technological Institute, Nawabganj, Kanpur.
Ghose, Sidhantha, Chemical Engineer.
Ghosh, B. K., Chemist, Drug Control Laboratory, Dept. of Chemistry, School of Tropical Medicine, Calcutta.
Ghosh, H. C., M.B.B.S., Sadar Hospital, Chapra, Bihar.
Ghosh, P. C., Deputy Director of Agriculture, Patna.

Ghosh, R. N., M.Sc., Dariapore, Patna.
Ghosh, S. M., M.A., C|O S. M. Ghosh, Asst. Post Master General, Patna.
Ghosh, S. M., M.Sc., Asst. Post Master General, Patna.
Ghosh, S. S., M.Sc., Dept. of Pure & Applied Chemistry, Indian Institute of Science, Bangalore.
Govande, C. K., Dept. of Agriculture, Baroda.
Gupta, Ajoy, M.Sc., Cipla Laboratories, Byculla, Bombay 8.
Gupta, Atulendu, Swarnasan Lane, Patna.
Gupta, A. K., P. W. Medical College, Patna.
Gupta, B., Major, I.A.M.C., C.M.H., Lucknow.
Gupta, B. K., Professional Asst., Meteorological Office, Poona 5.
Gupta, G. N., Research Chemist, H. B. Technological Institute, Nawabganj, Kanpur.
Gupta, N. N., Research Scholar, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta.
Gupta, Shyam Lal, M.Sc., Dept. of Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.
Gupta, Siddheswar, Retd. Headmaster, Chowhatta, Bankipore, Patna.
Gupta, Sujit Kumar, C|O Dr. H. K. Sen, New Market, Patna.
Gupta, S. B., D.T.M., Palira Clinical Laboratory, P.O. Bankipore, Patna.
Gupta, (Mrs.) Urmilla, B.A., C|O Dr. S. B. Gupta, D.T.M., Patna Chemical Laboratory, P.O., Bankipore, Patna.
Gupta, (Mrs) V., M.A., Lecturer, Degree College for Women, Patna.
Gyani, P. P., M.Sc., Dept. of Chemistry, Science College, P.O. Bankipore, Patna.

H

Hafez, Abdul, Lecturer in Psychology, Mysore University, No. 1878|1, Sawday Road, Mysore City.
Halim, A., M.A., Ph.D., Fida Mangila, Near Diggi, Aligarh.
Hattiangdi, M. S., Kalewar Bungalow, Deccan, Gymkhana, Poona 4.
Huddar, B. B., Asst. Meteorologist, Meteorological Office, Poona 5.
Husain, T., Patna City,

I

Iyer, S. Janardana, Research Asst., Statistical Laboratory, Trivandrum.

J

Jayarajan, A. P., Professional Asst., Meteorological Office, Poona 5.
Job, Samuel, V., B.Sc., Research Asst., Office of the Assistant Director of Fisheries Development, 8, Ormes Road, Kilpauk, Madras.
Joshi, C. P., Physical Research Laboratory, Shahibag, Ahmedabad.

K

Kalyanasundaram, V., Professional Asst., Meteorological Office, Poona 5.
Kapoor, B. R., Engineer, C. S. Gammon Ltd., Bombay.
Kapoor, S. N., Research Asst., H. B. Technological Institute, Nawabganj, Kanpur.
Karandikar, R. V., M.Sc., Research Fellow, C|O Upper Air Office, Lodi Road, New Delhi.
Karnik, M. G., Technological Laboratory, Matunga, Bombay 19.
Kazimali, Aligarh.
Kesavamoorthy, A., Professional Asst., Meteorological Office, Poona 5.

Khadenga, Kama, M.B., Women's Hospital, Patna.
Khadenga, Madhu, M.B., Medical College, Patna.
Khan, S. Bashir Ahsan, P.O. Barh, Patna.
Khare, Gopal Prasad, M.A., Lecturer, Darbar College, Rewa.
Krishna, Rai Gopal, M.Sc., Anand Bagh, Patna City.
Krishnamurthi, B., M.A., Fishery Research Officer, 8, Ormes Road, Kilpauk, Madras.
Krishnamurty, B. H., M.Sc., Demonstrator in Physics, Andhra University, Waltair.
Kshirsagar, G. R., Baroda College, Baroda.
Kupuswamy, P. B., G.M.V.C., B.V.Sc., Patna.

L

Lal, Babu Shio Kumar, Asst. Secretary, Basic Education Board, Bihar.
Luktuke, S. N., Indian Veterinary Research Institute, Izatnagar.

M

Majumdar, (Miss) Kanak, Post Graduate Girls' Hostel, 56, Harrison Road, Calcutta 9.
Malarkar, M. C., M.Sc., Biochemical Laboratory, Dacca University, Dacca.
Mathen, K. K., M.A., All India Institute of Hygiene & Public Health, 110, Chittaranjan Avenue, Calcutta.
Mathur, G. C., Institute of Psychological Research Service, Patna University, Patna.
Mazumdar, Ajit, M.Sc., Finance Department, Govt., of India, New Delhi.
Mazumdar, (Miss) Mira C|O Dr. B. P. Mazumdar, Bayley Road, Patna.
Mehta, H. P., C|O Mr. R. T. Saklath, Bow Bazar P.O., Calcutta 12.
Mene, P., Ph.D., Nagpur University, Nagpur.
Mitra, N. L., Additional Lecturer in Anatomy, P. W. Medical College, Patna.
Mitra, S. K., Institute of Psychological Service, Patna University, Patna.
Mitra, S. N., M.Sc., Bengal Immunity Research Laboratory, 153, Dharamtolla Street, Calcutta.
Mittra, Chandidas, Executive Engineer, Patna.
Mishra, J. M., Darbhanga Medical College, Patna.
Mishra, Sri Mohan, P. W. Medical College, Patna.
Mookerjee, K. C., M.A., Institute of Psychological Service, Patna University, Patna.
Mookerjee, N. P., Prof. & Head of the Chemistry Dept. Dungar College, Bikaner.
Moosath, S. S., M.Sc., Archaeological Chemist to the Govt. of Travancore.
Mouly, V. Chandra, B.Sc., Central Agricultural Marketing Dept., Patna.
Mukherjee, Akhil Chandra, Khajanchi Road, Bankipore, Patna.
Mukherjee, D. P., Indian Veterinary Research Institute, Izatnagar.
Mukherjee, H. N., Ph.D., Asst. Agricultural Chemist, Bihar, Sabour.
Mukherjee, J. B., M.B., 11|1A, Justice Dwarkanath Road, Calcutta 20.
Mukherjee, S. G., Prof. B. N. College, Patna.
Mukherjee, S. N., Purulia.
Mukherjee, Santi Ram, Asst. Professor of Maths & Surveying, Engineering College, Benares Hindu University, Benares.
Mukherjee, Subodh Gopal, M.Sc., Professor of Botany Jagannath Inter-mediate College, Dacca.
Mukherji, K. C., Mahendra, Patna.
Mukund, Ram, B.Sc., Manager, Pradip Lamp Works, Patna City.
Murthy, A. R. Vasudeva, Lecturer in Chemistry, Central College, Bangalore.
Murty, V. N., M.Sc., Animal Nutrition Section, Indian Veterinary Research Institute, Izatnagar.
Muthanna, M. S., Chemistry Dept., Indian Institute of Science, Malleswaran P.C., Bangalore.

N

Nair, K. Ramachandran, C|O Dr. K. L. Moudgill, University of Travancore, Trivandrum.
Nair, N. Gopalakrishnan, C|O Mr. S. Janardhana Iyer, Research Asst., Statistical Laboratory, Trivandrum.
Nambiar, A. Kunhikoran, C|O Sri C. Vijayaraghavan, Agricultural College & Research Institute, P.O. Lawley Road, Coimbatore.
Narayanan, E. S., M.A., Ph.D., Parasitologist, Indian Agricultural Research Institute, New Delhi.
Nataraj, S., Asst. Research Officer, The Marine Biology & Fisheries, Trivandrum.
Negi, S. S., Animal Nutrition Section, Indian Veterinary Research Institute, Izatnagar.
Nene, Y. R., M.Sc., 425, Narayan Peth, Poona 2.
Nilukantan, P. R., Research Asst., Indian Veterinary Research Institute, Mukteswar-Kumaun.

P

Pal, N., Bankipore, Patna.
Pani, Shripati, Demonstrator in Chemistry, Revenshaw College, Cuttack.
Panicker, C. G. G., College of Engineering & Technology, Jadavpur, 24, Parganas.
Paranjape, M. K., Ph.D., Physics Department, S. P. College, Poona 2.
Patnaik, H. M., Science College, Patna.
Patnaik, R., 36, Handinge Road, Patna.
Pattanaik, Shyamananda, Botany Dept., Sambalpur College, Orissa.
Perumal, S., Senior Soil Survey Officer, Main Farm, Himayatsagar, Hyderabad-Dn.
Pillai, K. Parameswaran, Prof. of Marine Biology & Fisheries, Trivandrum.
Pillai, K. S. Madhavan, M.Sc., Lecturer, University College, Trivandrum.
Pillai, K. Sadasivan, B.Sc., Asst., Chemist, Fishery Development Scheme, Central Research Institute, Trivandrum.
Pillai, Sreedharan, B.A., Chemical Asst., Dept. of Applied Chemistry, Trivandrum.
Pillay, K. C. Sreedharan, C|O Mr. S. Janardhana Iyer, Research Asst., Statistical Laboratory, Trivandrum.
Pishorty, P. R., Meteorologist, Weathers Office, Poona 5.
Poti, A. Narayanan, C|O Dr. K. L. Moudgill, University of Travancore, Trivandrum.
Prajapati, Hiranmoy, Retd. Govt. Sub. Asst. Surgeon, P.O. Gulzarbagh, Patna.
Prakash, Om., Institute of Psychological Service, Patna University, Patna.
Prasad, A. B., Anand Bhawan, Darbhanga.
Prasad, Hari, Blood Bank, Patna.
Prasad, Jaikishore, Kadamkuan, Patna.
Prasad, K. N., Asst. Director of Agriculture, South Bihar Circle, Patna.
Prasad, Kailas Behari, M.Sc., Lecturer in Chemistry, Science College, Patna.
Prasad, Parmeshwar, M.Sc., Dept. of Chemistry, Science College, Patna.
Prasad, Kamleshwari, M.Sc., G. B. B. College, Muzaffarpur.
Prasad, Parmeshwar, M.Sc., Dept. of Chemistry, Science College, Patna.
Prasad, Ramchandra, M.Sc., Dept. of Mathematics, Science College, Patna.
Prasad, Rajendra, Asst. Director of Agriculture, Bihar Agricultural Society, Patna.
Prasad, S. L., C|O Dr. P. N. Sinha, D. O.M.S., Patna.
Prasad, Tribhuwan, M.Sc., Professor of Mathematics, D. T. College, Monghyre.
Punnoosi, T. V., B.Sc., Lecturer, Institute of Textile Technology, Trivandrum.
Purohit, M. M., Ranchi Stores, Ranchi.

Q

Quadros, Marie, M.B., Medical College, Patna.
Qumruddin, Mohammad, M.B., B.S., Patna Medical College Hospital, Patna.

R

Rai Chaudhuri, M. N., M.B., Dept. of Tropical Medicine, School of Tropical Medicine, Calcutta.
Rakshit, P. C., M.Sc., Bengal Immunity Research Laboratory, 153, Dharamtolla Street, Calcutta.
Ramaiyer, G., 11, Strand Road, Patna.
Ramakrishnan, T. A., M.Sc., Chemist, Govt. Shark Liver Oil Factory, Central Research Institute, Trivandrum.
Ramamurti, K. S., 1206|8B, Municipal Colony, Poona 4.
Ramanathan, V., M.Sc., Asst. Director of Fisheries, 8, Ormes Road, Kilpauk, Madras.
Ramanji, G., C|O Awadhesh Nandan Sahay, Kadamkuan, Patna.
Rangappa, K. S., M.Sc., Dept. of Biochemistry, Indian Institute of Science, Malleswaran P.O., Bangalore.
Rao, C. V., Animal Veterinary Research Institute, Izatnagar, Bareilly.
Rao, D. A. A. S. Narayana, M.Sc., Lecturer, Physics Dept., Andhra University, Waltair.
Rao, D. V., Observatory, Madras 16.
Rao, G. Lakshminarayan, M.A., Fishery Information Officer, 8, Ormes Road, Kilpauk, Madras.
Rao, K. V. K., Mining Engineer, Gwalior.
Rao, M. A. G., D.Sc., Madras University, Madras.
Rao, M. Bhimsena, Dept. of Chemistry, Central College, Bangalore.
Rao, S. Nagaraja, Fresh Water Biological Research Station, Fishland, Kilpauk, Madras.
Rao, T. Kamesundara, Andhra Scientific Co., Ltd., Masulipatam, S. India.
Rao, V. T. N., Chemist in-charge, Saidpur, Patna.
Ray, N., M.Sc., Bengal Immunity Research Laboratory, 153, Dharamtolla Street, Calcutta.
Rohatgi, (Mrs.) Krishnabala, C|O Mr. Ram Mukund, Manager, Pradip Lamp Works, Patna City.
Rohatgi, Kumar Kishore, 45, Armenian Street, Calcutta.
Rohatgi, Manmohan, Dhawlpura Kuthi, Patna City.
Rohatgi, Shakuntala, C|O B. K. Rohatgi, 45, Armenian Street, Calcutta.
Roy, Bijon Krishna, M.Sc., Aukshoy Kutir, Kadamkuan, Patna.
Roy, (Mrs.) Madhuri, Jadavpur College, Jadavpur, 24 Parganas.
Roy, P. K., Lecturer in Chemistry, The Bihar Agricultural College, Sabour.
Roy, Prahlad, 25, Southern Avenue, Calcutta.
Roy, S. C., Medical College Hospital, Patna.
Roy, Sanat K., C|O Prof. N. S. N. Nath, Prof. of Mathematics, Science College, Patna.

S

Sadasivan, V., C|O P. R. Sadasivan Tampi, Central Marine Fisheries Station, Triplicane P.O., Madras.
Sahai, Karta, M.Sc., Bareilly College, Bihanpur, Bareilly.
Sahay, Ramji, C|O Phulan Pd. Verma, Kadamkuan, Patna.
Sahi, Upendra Narain, P. W. Medical College, Patna.
Salabuddin, Science College, Patna.
Salaruddin, M., Meteorologist, Meteorological Office, Poona 5.
Samuel, C. K., Asst. Entomologist, Indian Agricultural Research Institute, New Delhi.
Saran, Govind, Patna.
Sardarni, (Mrs.) C|O L. Singh, "Achiut", P.O. Bankipore, Patna.
Sarkar, A. K., B.Sc., Asst. Marketing Officer, Bihar, Patna.
Sarkar, Jagannath, Mining College, Dhanbad.
Sarkar, Satya Sadhan, M.Sc., Senior Lecturer in Geology, University of Rangoon, Burma.

Sarna, V. C., Meteorological Asst. Meteorological Office, Poona 5.
Sastry, L. V. L. N., M.Sc., Animal Nutrition Section, Indian Veterinary Research Institute, Izatnagar, Bareilly.
Satyayantarao, S. V., B.Sc., Research Asst. Andhra Scientific Co., Ltd., Masulipatam.
Sen, A. R., Asst. Statistician, U. P. Govt., Bihar.
Sen, (Mrs.), Maya, 34, Circuit House Area, Jamshedpur.
Sen, (Miss) Myra, Dept. of Geology, University of Calcutta, Geological Laboratory, Presidency College, Calcutta.
Sen, Nalin, Chemical Engineer.
Sen, S., M.B., Patna Gaya Road, Patna.
Sen Gupta, P. K., Appelate Commissioner of Income Tax, Patna.
Sen Gupta, P., 27, Hardinge Road, Patna.
Sen Gupta, S. N., M.A., Professor of English, B. N. College, Patna.
Seetharaman, C., Asst. Research Officer (Bacteriology), Indian Veterinary Research Institute, Mukteswar, Kumaun.
Sharfuddin, (Mrs.) Z., Warden's Bunglow, Patna College, Patna.
Sharga, Rajeshwari, C|O B. K. Rohatgi, 45, Armenian Street, Calcutta.
Shanker, Gauri, B.Sc., Science College, Patna.
Sharma, G. L., L.V.P., Research Asst. Indian Veterinary Research Institute, Mukteswar-Kumaun.
Sharma, Nawal Keshore, Kajipur, Bankipore P.O., Patna.
Sharma, Surendra Prasad, Medical College, Patna.
Sharma, Sukhdeo Singh, M.A., Lecturer in Philosophy, Patna College, Patna.
Shaw, S. K., Dariapore Gola, Patna.
Shaw, Tarachand, Dardiapore Gola, Patna.
Shrivastava, Shital Charan, Institute of Psychological Research Service, Patna University, Patna.
Shukla, D. D., Indian Veterinary Research Institute, Izatnagar.
Sikdar, J., M.Sc., Bengal Immunity Research Laboratory, 153, Dharamtolla Street, Calcutta.
Singh, Bhola, M.Sc., Dept. of Mathematics, Science College, Patna.
Singh, Darshan, M.Sc., Science College, Patna.
Singh, Damodar Prasad, M.Sc., C|O Prof. Shivrajdeb Prasad, B. N. College, Patna.
Singh, Harbans, B.A., L. V. P., Research Asst., Indian Veterinary Research Institute, Mukteswar-Kumaun.
Singh, M. P., Asst. Economic Botanist, Bihar.
Singh, Prem, P.O. Mahendra, Patna.
Singh, Ram Adhin, Office of the Commissioner of Income Tax, Patna.
Singh, R. S., Professor of Zoology, T. N. J. College, Bhagalpore.
Singh, S. N., M.Sc., Animal Nutrition Research Institute, Izatnagar.
Singh, Sardar Lakhmir, "Achiut", P.O. Bankipore, Patna.
Singh, Y. V., Medical College, Patna.
Sinha, (Miss) Aruna, Institute of Psychological Research Service, Patna University, Patna.
Sinha, Aswini Kumar, B. M. Das Road, Patna.
Sinha, Bholanath, Patna.
Sinha, D. P., Medical College, Patna.
Sinha, H. B., Add. Lecturer, P. W. Medical College, Patna.
Sinha, Jang Bir, Development Director, Ministry of Industries & Supply, New Delhi.
Sinha, Kusum, C|O Shree B. N. Prasad, New Area, Kadamkuan, Patna.
Sinha, Purushottam, Asst. Professor of Pharmacognosy, Benares Hindu University.
Sinha, R. N., Casantly Officer, Patna Medical College Hospital, Patna.
Sinha, Sheo Dayal, Senior Chemical Asst., C.S.R.S., P.O. Pusa, Darbhanga.
Sinha, S. R. P., Medical College Hospital, Patna.
Sivaramakrishnan, M. V., Meteorological Asst., Meteorological Office, Poona 5.

Sivaramakrishnan, N. H., General Chemistry Dept., Indian Institute of Science, Malleswaram P.O., Bangalore.
Sreenivasan, P. S., C|O Director, Agricultural Meteorology, Meteorological Office, Poona 5.
Srivastava, G. P., Professor, Hindu University, Benares.
Subbiah, R., Chemistry Dept., A. V. N. College, Vizagapattam.
Subrahmoya,R. S., Research Asst. Dept. of General Chemistry, Indian Institute of Science, Bangalore.
Subramoney, N., B.Sc., Asst. Chemist, Central Research Institute, Trivandrum.
Swami, N. P., Representative, The Andhra Scientific Co., Ltd., Cuttack.
Swaroop, Satyendra, Science College, Patna.
Syalee, S. S., Psychiatrist, C. M. H. Ramgarh, Dist. Ranchi.

T

Talekar, V. L., M.Sc., Prof. of Physics, Dungar College, Bikaner (Rajputana).
Tampi, P. R., Sadasivan, M.Sc., Central Marine Fisheries Station, Triplicane P.O., Madras.
Tewari, M. N., Mitapur, Patna.
Thakur, P. S., C|O Dr. K. G. Joshi, Biochemist to C. P. Govt., Dept. of Agriculture, Nagpur.
Thivy, (Mrs.) Dr. Francesca, Freshwater Biological Station, Fishlands, Kilpauk, Madras.
Tiwari, S. C., T. N. G. College, Bhagalpore.
Tiwari, Tripuranand, P. C. School, Patna.
Tiwary, Govind Pati, Manager Manjha & Sursand Estate & Honorary Magistrate, Hathwa, P.O. Hathwa, Dt. Saran.

U

Upadhya, Pundit R. S., Secretary, Basic Education Board, Bihar.
Upadhyay, Binoy K., Station Road, Patna.
Upadhyay, H. P., Sinha Library Road, Patna.
Upadhyay, R. P., Sinha Library Road, Patna.

V

Vaishya, Mahendra Prasad, House Surgeon, P. M. C. H.
Varier, N. S., M.Sc., Senior Chemist, Fishery Dept. Scheme, Central Research Institute, Trivandrum.
Varma, K. Bhaskaran, C|O Mr. S. Janardhana Iyer, Research Asst., Statistical Laboratory, Trivandrum.
Varma, R. S., D.Sc., Reader in Mathematics, Lucknow University, Lucknow.
Venkateswar, V. S., M.Sc., Lecturer & Head of the Dept. of Zoology, A. V. N. College, Maharanipet P.O., Vizagapatam.
Verma, B. P., Science College, Patna.
Verma, C. P., B.Sc., Superintendent, Fisheries, Dept. of Industries, Bihar, Patna.

W

Wariar, U. Achyutha, C|O Sri C. Vijayaraghavan, Millet Specialist, Agricultural College and Research Institute, P.O. Lawley Road, Coimbatore.
Warior, (Miss) Shanta, Institute of Psychological Research Service, Patna University, Patna.

Y

Yunus, (Mrs.) M., Fraser Road, Patna.

LIST OF STUDENT MEMBERS

A

Adhikari, B. P., Post-Graduate Dept. of Statistics, Calcutta University, Calcutta.
Agarwal, Engineering College, Patna.
Agarwal, Prem Kishore, Darbhanga Medical College, Darbhanga.
Agrawal, R. P., H. B. Technological Institute, Kanpur,
Ahmad, Ebser, Science College, Patna.
Ahmed, Maujoor, D. Engineering Hostel, Mahendra, Patna.
Ahmad, N., Geology Dept., Patna University, Patna.
Ahmed, Nasim, Muslim University, Aligarh.
Ahmed, Nesar, P.W.Medical College, Patna.
Ahsan, G. Mehdi, 14, Mecdonel, Muslim University, Aligarh.
Ahsan, S. M. Neaz, Muslim University, Aligarh.
Akhtar, Saeed, Muslim University, Aligarh.
Akhtar, Saeed, Muslim University, Aligarh.
Akhtar, S. H., Science College, Patna.
Akhtar, S. W., Agricultural College, Bihar.
Ali, Md. Abbas, Bihar Agricultural College, Sabour.
Ali, Muhamad, Science College, Patna.
Ambasth, Sakli Prasad, Bihar Agricultural College, Sabour.
Amin, D. L., C|O. Prof. T. K. Deolalkar, Head of the Dept. of Physics, Karnatak College, Dharwar.
Ansari, Wasi Ahmad, 25, Medical College Hostel, Patna.
Arora, (Miss) K. D., Medical College, Patna.
Aziz, A., Science College, Patna.

B

Badami, G. N., General Chemistry Section, Indian Institute of Science, Bangalore.
Bahadur, Surendra, Lahiri Villa, Yollpore, Patna.
Banerjee, M. K., Medical College, Patna.
Banerjee, Mrinal Kanty, P.W.Medical College, Patna.
Banerjee, Dev Prasad, Medical College, Patna.
Banerjee, S. K., Agricultural College, Bihar.
Banerjee, Kamala Ranjan, P.W.Medical College, Patna.
Banerjee, Tapan Kumar, Science College, Patna.
Banerjee, (Miss) Pushpa, C|O. S. C. Banerjee, Mithapur, Patna.
Banerji, Ranan Behari, C|O. Dr. S. K. Chatterjee, Dak Bungalow Road, Patna.
Barmi, A. L., C|O. Dr. P. C. Guha, Prof. of Organic Chemistry, Indian Institute of Science, Bangalore.
Basu, D. S., Student of Mining, Benares Hindu University, Benares.
Bhar, Chandra Nath, C|O. Dr. D. Chakravarty, Science College, 92, Upper Circular Road, Calcutta 9.
Bhattacharya, Amiya Prosad, Applied Chemistry Dept., University College of Science, 92, Upper Circular Road, Calcutta 9.
Bhattacharya, (Miss) G., Medical College, Patna.
Bhattacharyya, N. N., Benares Hindu University, Benares.
Bhatia, N. S., C|O. Dr. S. K. K. Jatkar, Dept. of Pure & Applied Chemistry, Indian Institute of Science, Bangalore.
Biswas, H. D., Medical College, Patna.

Biswas, Harishikesh Das, P.W.Medical College, Patna.
Bole, Navin Chandram, Geology Department, Presidency College, Calcutta.
Bose, A. N., Chemistry Dept., Lucknow University, Lucknow.
Bose, Bimal Kumar, Art College, Patna.
Bose, Deb Kumar, Applied Chemistry Dept., University College of Science, 92, Upper Circular Road, Calcutta 9.
Brahma, M. C., Bihar Engineering College, Patna.
Brahma, Sudhish Chandra, Engineering College, Patna.
Brahma, Sri Rama, Dept. of Psychology, Patna University, Patna.

C

Chacko, O., C|O. Director, Agricultural Meteorology, Meteorological Office, Poona 5.
Chand, Mahadeo, Darbhanga Medical College, Darbhanga.
Chanda, Nikhil Bh., Bose Research Institute, 93, Upper Circular Road, Calcutta.
Chanda, Probir Bh., St. Paul's College, Calcutta.
Chandra, Akhilesh, Science College, Patna.
Chandra, Ganesh, Laxmi Nivas, Prem Nagar, Kanpur.
Charan, Shyama, Geology Dept., Patna University, Patna.
Chaudhuri, B., Science College, Patna.
Chaudhuri, Gouranga, Engineering College, Patna.
Chaudhury, Harshnath, Patna College, Patna.
Chaudhury, Ram Nandan, Patna College, Patna.
Chatterjee, Ashok, Science College, Patna.
Chatterjee, Binoy Kumar, C|O. Prof. D. N. Chatterjee, Park-View, Kadamkuan, Patna.
Chatterjee, Devaprasad, Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.
Chatterjee, Dilip Kumar, Science College, Patna.
Chatterjee, Hrishikesh, Pre-Medical Class, Science College, Patna.
Chatterjee, (Miss) Ketaki, Gardanibag, Patna.
Chatterjee, Indra, C|O. Sj. N. Chatterjee, Boarding Road, Colonelgung, Patna.
Choubey, R. A. Leshwar, Patna College, Patna.
Chattopadhyay, Dipali, C|O. N. Chatterji, Boarding Road, Colonelgung, Patna.
Choudhuri, Abdus Subhan, P.W.Medical College, Patna.
Chowdhury, Amalendra, Applied Chemistry Dept., University College of Science, 92, Upper Circular Road, Calcutta 9.
Chowdhury, A. S., Medical College, Patna.
Choudhury, Bishun Charan, Patna College, Patna.
Chowdhury, Chhedi, Science College, Patna.
Chowdhury, Dipti Kalyan, Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.
Chowdhury, K., Benares Hindu University, Benares.
Chowdhury, R., Benares Hindu University, Benares.

D

Dalve, V. J., C|O Dr. R. C. Shah, Professor of Organic Chemistry, Royal Institute of Science, Mayo Road, Bombay.
Das, (Miss) Aruna Bala, Patna Women's College, Patna.
Das, Debabrata, Science College, Patna.
Das, G., 15, Rama Prasad Roy Lane, Opp. Kailash Bose Street, Calcutta.
Das, Ganeshwar Lal, Medical College, Patna.
Das, Gangadhar, Patna Medical College, Patna.
Das, Janardan Prosad, Engineering College, Patna.

Das, Keshav Kumar, B. N. College, Patna.
Das, M. L., Engineering College, Patna.
Das, Nityanand, Science College, Patna.
Das, Pranabendra, B. N. College, Patna.
Das Gupta, P. K., Benaras Hindu University, Benaras.
Das Gupta, Paresh, Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.
Das Gupta, Santosh Kumar, Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.
Das Sharma, Premananda, 56, Pearch Road, P.O. Lillooah, Dt. Howrah.
Dastidar, Nikhil, Roll 55, Science College, Patna.
Das Verma, R. N., Science College, Patna.
Datta, Arjya Kumar, Applied Chemistry Dept., University College of Science, 92, Upper Circular Road, Calcutta 9.
Datta, Saradindu, Science College, 92, Upper Circular Road, Calcutta 9.
Dayal, Kapileshwar, Patna College, Patna.
Dayal, Narbadeshwar, Bihar Engineering College, Patna.
De, Chitta Prosad, Applied Chemistry Dept., University College of Science, 92 Upper Circular Road, Calcutta 9.
De, Prasun Kumar, Science College, Patna.
De, (Miss) Renu, Medical College, Patna.
Deb, Sakh, C|O. Dr. P. C. Guha, Professor of Organic Chemistry, Indian Institute of Science, Bangalore.
Debi, (Miss) Hem Priya, Patna College, Patna.
Devi, (Miss) S., Medical College, Patna.
Devi, (Miss) Shakuntala, C|O. Mr. S. P. Singh, Sinha Library Road, Patna.
Devlalkar, (Miss) Sudha, Dept. of Biochemistry, Indian Institute of Science, Malleswaram, Bangalore.
Dipali, N. L., Mangalwarpet, Dharwar.
Dutta, (Miss) Aruna, Women's College, Patna.
Dvbey, Akhilesh, Science. College, Patna.

G

Ganguly, Chinmoy Kumar, Science College, Patna.
Ganguly, Gauri Shankar, Patna Collegiate School, Patna.
Ghatak, Sushil Kumar, Science College, Patna.
Ghosal, Amitava, Room No. 67. W-5. Eden Hindu Hostel, 3, Pyari Sarkar Street, Calcutta 7.
Ghosh, A. K., C|O. Prof. Mata Prasad, Principal, Royal Institute of Science, Bombay.
Ghosh, Pranab Kumar, B. N. College, Patna.
Ghosh, Jagodish Chandra, Science College, Patna.
Ghosh, (Miss) Nirmala, Gardanibag, Patna.
Ghosh, (Miss) R. S., Medical College, Patna.
Ghosh, Subhash, Bihar College of Engineering, Patna.
Ghosh, S., C|O. Dr. P. K. Ghosh, Geological Survey of India, 27, Chowringhee, Calcutta.
Ghosh, Tarun Kumar, Science College, Patna.
Ghosh, Nripendra Nath, C|O Prof. P. Ray, University College of Science, 92, Upper Circular Road, Calcutta 9.
Gokhale, M. S., Post-Graduate Dept. of Statistics, Calcutta University, Calcutta.
Gopalakrishnan, T. S., B.Sc., 253, Broacha Hostel, Hindu University P.O., Benares.
Gopalaswamy, S. N., C|O Dr. S. K. K. Jatkar, Dept. of Pure & Applied Chemistry, Indian Institute of Science, Malleswaram P.O., Bangalore.
Gopalkrishnan, K., C|O Spectroscipic Laboratories, Physics Dept., Royal Institute of Science, Mayo Road, Bombay 1.

Gope, R. D., Medical College, Patna.
Goswami, R., P. W. Medical College, Patna.
Govinda, H. C., Dept. of Botany, Central College, Bangalore.
Govindaswamy, T. S., C|O Director, Agricultural Meteorology, Meteorological Office, Poona 5.
Griffiths, J. G., C|O Director, Agricultural Meteorology, Meteorological Office, Poona 5.
Guha, J. R., C|O Dr. P. C. Guha, Professor of Organic Chemistry, Indian Institute of Science, Bangalore.
Gupta, Arun, C|O M. S. Gupta, Sougertoli, Patna.
Gupta, A. K., Science College, Patna.
Gupta, H. N., Student, Statistics Dept. Ashutosh Building, Calcutta University. Calcutta.
Gupta, M. G., H. B. Technological Institute, Kanpur.
Gupta, (Miss) Kanika, Private Student, Patna.
Gupta, (Miss) Kalyani, B.A., Patna College, Patna.
Gupta, (Miss) Monjori, Patna Women's College, Patna.
Gupta, Nity, Patna Women's College, Patna.
Gupta, Rama Sakal, B. N. College, Patna.
Gupta, Raghubansh Mani, Engineering College, Patna.
Gupta, S. N., Science College, Patna.
Gupta, Subrata, Science College, Patna.
Gupta, (Miss) Uma, Philosophy Dept. Patna College, Patna.

H

Hague, Ashraful, Science College, Patna.
Hasan, Khawaja Mayar, Muslim University, Aligarh.
Hashim, Muslim University, Aligarh.
Hasnain, 31, S. S. East, Aligarh.
Hasibuddin, B. N. College, Patna.
Hassan, Amir, Science College, Patna.
Hasun, Syed, Bihar College of Engineering, Patna.
Hazari, Kalyan, C|O Mr. Pravat Kumar Sinha, Bharat Bank, Bhagalpore.
Hiralal, Science College, Patna.
Howell, Thomes F., 4, C. F. Andrawas Road, Kaimari, Karachi 7.
Husain, Arif, Muslim University, Aligarh.
Husain, Mohd, Sarwat, 34, Macdonel House, Muslim University, Aligarh.
Husain, Mozaffer, B. N. College, Patna.
Husain, S. Reaz, Engineering College, Patna.
Hussain, S. Muzaffer, Mtab Hostel, Muslim University, Aligarh.
Hussain, Lilly, Faraday Hostel, Science College, Patna.

I

Ingle, T. R., C|O Prof. B. V. Bhide, Maharaja Pratapsingh Chemical Laboratory, Sri Parashurambhai College, Poona 2.
Iyengar, B. R. Cheluva, General Chemistry, Section, Indian Institute of Science, Bangalore.
Iyengar, B. R. Y., C|O Dr. S. K. K. Jatkar, Indian Institute of Science, Bangalore.

J

Jain, P. K., Medical College, Patna.
Jaiswal, Tej Naraian Prasad, P. W. Medical College, Patna.

Jamal, S., Bihar Engineering College, Patna.
Jaysawal, K. C., B. N. College, Patna.
Jha, Chandra Shekhar, Science College, Patna.
Jha, Chakradhar, P. W. Medical College, Patna.
Jha, Devendra; P. W. Medical College, Patna.
Jha, Girijesh Kumar, Science College, Patna.
Jha, Sitaram, Bihar College, of Engineering, Patna.
Jogalekar, P. R. C|O Prof. B. V. Bhide, Maharaja Pratapsingh Chemical Laboratory, Sri Parashurambhai College, Poona 2.
Joshi, D. V., C|O Dr. R. C. Shah, Prof. of Organic Chemistry, Royal Institute of Science, Mayo Road, Bombay 1.
Joshi, Krishnachandra, M.Sc., C|O Pandit P. N. Joshi, Model House, Bye-Lane East, Lucknow.

K

Kakati, L. M., Medical College, Patna.
Kakoti, Lalit Mohan, P. W. Medical College, Patna.
Kale, K. S., Meteorological Office, Poona 5.
Kalyansundaram, A., C|O Dr. S. S. Joshi, Benares Hindu University, Science College, Benares.
Karan, J. P.; P. W. Medical College, Patna.
Katti, P. K., Meteorological Office, Poona 5.
Keolyar, Raj Mohan Nand, Patna College, Patna.
Keolyar, Ugramohan Nand, Patna College, Patna.
Keshava, H. C., Medical College, Darbhanga.
Khan, Ashfaq Ali, 43, MacD. House, Muslim University, Aligarh.
Khan, A. S., Medical College, Patna.
Khan, A. Z. M., Science College, Patna.
Khan, Qasim, Science College, Patna.
Kini, U. V., Benares Hindu University, Benares.
Korgaokar, K. S., C|O Spectroscopic Laboratories, Physics Dept., Royal Institute of of Science, Mayo Road, Bombay 1.
Krishnamurthy, K. S., C|O Director, Agricultural Meteorology, Meteorological Office, Poona 5.
Krishnaswami, N., C|O Mr. K. Ragothama Rao, Dept. of Biochemistry, Indian Institute of Science, Malleswaran, Bangalore.
Krishnaswamy, M., C|O Prof. C. R. Sankaran, Deccan College Research Institute, Poona 1.
Kulkarni, (Miss) S. B., C|O Dr. S. K K. Jatkar, Dept. of Pure & Applied Chemistry, Indian Institute of Science, Bangalore.
Kumar, Bimal, Applied Chemistry Dept., College of Science, 92, Upper Circular Road, Calcutta.
Kumar, Binod, Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.
Kumar, Girish, Science College, Patna.
Kumar, Kapil deo, Law College, Patna.
Kumar, Raghabendra, Medical College, Patna.
Kumar, Saroj, Science College, Patna.
Kumar, Satrughna, Science College, Patna.
Kumari, (Miss) Girija, Patna Women's College, Patna.
Kundra, J. C., Patna College, Patna.

L

Lall, Basant Kumar, Bihar Engineering College, Patna.

Laxminarayanan, D., C|O Dr. S. K. K. Jatkar, Dept. of Pure & Applied Chemistry, Indian Institute of Science, Bangalore.

M

Mahanjan, P. B., C|O R. C. Shah, Professor of Organic Chemistry, Royal Institute of Science, Mayo Road, Bombay 1.

Mahanty, S. R., C|O Dr. S. S. Joshi, Head of the Dept. of Chemistry, Benares Hindu University, Benares.

Mahapatra, Sukanti, Philosophy Dept., Patna College, Patna.

Mahto, Bhola, P.W. Medical College, Patna.

Majumdar, G. P., C|O Dr. D. D. Karve, Fergusson College, Patna.

Malkani, (Miss) G., Medical College, Patna.

Mallikajunappa, P., C|O. Dr. S. S. Joshi, College of Science, Benaras Hindu University, Benaras.

Mallick, Subandhu, Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, calcutta 9.

Mandal, Maheshwari Prasad, Science College, Patna.

Marwaha, (Miss) Swaran, Science College, Patna.

Mathew, P. K., Research Scholar, Dept. of Applied Chemistry, Trivandrum.

Mazumdar, Chittranjan, Dacca University, Dacca.

Mazumdar, Krishna Behari, Science College, Patna.

Mazumdar, Nripendra Narayan, Applied Chemistry Dept. University College of Science, 92, Upper Circular Road, Calcutta 9.

Mazumder, Shibani, Patna Women's College, Patna.

Mazumdar, T. K., Medical College, Patna.

Mehra, Brahma Swarup., M.Sc., Research Scholar in Botany, University of Allahabad, Allahabad.

Mehta, Ganga Ram, P. W. Medical College, Patna.

Melhotra, Sashi Mohan, D. D. V. College, Kanpur.

Menon, M. G. K., C|O Spectroscopic Laboratories, Physics Dept., Royal Institute of Science, Mayo Road, Bombay 1.

Merchant, J. R., C|O Dr. R. C. Shah, Prof. of Organic Chemistry, Royal Institute of Science, Mayo Road, Bombay 1.

Mhaskar, V. V., C|O Prof. B. V. Ehide, Maharaja Pratapsingh Chemical Lab., Sri Parashurambhai College, Poona 2.

Mishra, Kartik Nath, Science College, Patna.

Mishra, Kanai Lal, Patna College, Patna.

Mishra, Nalini Kant, Medical College, Patna.

Mishra, R. N., Medical College, Patna.

Mishra, Suryakant, Patna College, Patna.

Misra, Basisth Narayan, Science College, Patna.

Misra, Basudev, C|O Mr. P. C. Misra, Dariapugola, Bankipore P.O. Patna.

Misra, Gauri Sankar, Patna College, Patna.

Misra, Nirmal Kumar, C|O Mr. P. C. Misra, Dariapugala, P.O. Bankipore, Patna.

Misra, Shrideva, Patna College, Patna.

Misra, V. S., Chemistry Department, Lucknow University, Lucknow.

Mitra, (Miss) Preeti, 32|B, Shankaripara Road, Calcutta 25.

Mohammad, Syed Fazal, Muslim University, Aligarh.

Mohan, Anand, P. W. Medical College, Patna.

Mohapatra, Lakshmi Narayan, Medical College, Patna.

Mohiuddin, Science College, Patna.

Momin, A. U., Meteorological Office, Poona 5.

Mukherjee, Ajit Kumar, C. M. College, Darbhanga.

Mukherjee, Asoke, B: C. Engineering, A|270.
Mukherjee, Ajit Kumar, C. M. College, Darbhanga.
Mukherjee, Batakrishna, Medical College, Patna.
Mukherjee, Rabindra Nath, Dakbanglow Road, Patna.
Mukherjee, S., Road No. 6, Quarters 14, Gardanibagh, Patna
Mukherji, Kamaleshwar, Science College, Patna.
Mulay, (Mrs.) Indu, Karnatak College, Dharwar.

N

Nair, C. S. Bhaskaran, B.Sc., Research Student, Dept. of Applied Chemistry, Trivandrum.
Nair, K. N. Gopinathan, Research Student, Dept. of Applied Chemistry, Trivandrum.
Nair, S. S., Post-Graduate Dept. of Statistics, Calcutta University, Calcutta.
Nanda, Amarendra, Patna College, Patna.
Narayan, Birendra, Science College, Patna.
Narayan, Jagdish, B. N. College, Patna.
Narayan, Kirit, B.Sc., Science College, Patna.
Nath, Devender, B. N. College, Patna.
Nath, Narendra, C|O Dr. S. S. Joshi, Science College, Benares Hindu University, Benares.
Nayak, Ramdeo, Patna College, Patna.
Neogy, (Miss) G., Medical College, Patna.
Nayak, Iswar Chandra, Bihar College of Engineering, Patna.

O

Oraon, Kartik, Engineering Hostel, Patna.

Pal, M. R., C|O Prof. B. V. Bhide, Maharaja Pratapsingh Chemical Laboratory, Sri Parashurambhai College, Poona 2.
Palwardhan, M. V., C|O Prof. B. V. Bhide, Maharaja Pratapsingh Chemical Laboratory, Sri Parashurambhai College, Poona 2.
Panday, Bhup Narain, Prince of Wales Medical College, Patna.
Panday, Chandi Prasad, Pre Medical Class, Science College, Patna.
Panday, Jagdish Prasad, Patna College, Patna.
Pandey, Ramaprasad, Patna College, Patna.
Pandey, Shiwshankar, Science College, Patna.
Pandeya, Satish Chandra, Saugar University, Saugar.
Pandit, S. S., C|O Dr. R. C. Shah, Prof. of Organic Chemistry, Royal Institute of Science, Mayo Road, Bombay.
Pankajakshyamma, (Miss) K., B.Sc., Research Scholar, Dept. of Applied Chemistry, Trivandrum.
Pankajakshyamma, (Miss) T., B.Sc., Research Scholar, Dept. of Applied Chemistry, Trivandrum.
Parija, P. R., Presidency College, Patna.
Parija, (Miss) S., Medical College, Patna.
Patel, C. C., General Chemistry Section, Indian Institute of Science, Bangalore.
Patel, I. B., C|O Dr. P. C. Guha, Professor of Organic Chemistry, Indian Institute of Science, Bangalore.
Patel, J. M., C|O Spectroscopic Laboratories, Physics Dept., Royal Institute of Science, Mayo Road, Bombay 1.
Pathak, Gauri Nath, Science College, Patna.

Pathak, Kashinath, Darbhanga Medical College, Darbhanga.
Pati, Kailash, Patna College, Patna.
Patnaik, Jay Kishore, Science College, Patna.
Pillai, K. Krishna, The Prof. of Marine Biology & Fisheries, Shankumugam, Trivandrum.
Pillai, R. Krishna, Research Student, Dept. of Applied Chemistry, Trivandrum.
Poddar, Ramnarayan, Jackson Hostel, Patna College, Patna.
Pradhan, P. C., C|O Dr. S. S. Joshi, Benares Hindu University, Science College, Benares.
Prasad, Ajodhya, Science College, Patna.
Prasad, Akhileshwar, Science College, Patna.
Prasad, Anirudha, Science College, Patna.
Prasad, Anandeo, B. N. College, Patna.
Prasad, Anirudh, P. W. Medical College, Patna.
Prasad, Awadh Behari, Lahiri Villa, Yoypore Road, Patna.
Prasad, Baleswar, Pre-Medical Class, Science College, Patna.
Prasad, Banshidhar, P. W. Medical College, Patna.
Prasad, Biadyanath, Bihar Medical College, Patna.
Prasad, Bishweshwar, Patna College, Patna.
Prasad, Brajaraj Deva, Science College, Patna.
Prasad, Braj Bhusan, Medical College, Patna.
Prasad, Brojnandan, B. N. College, Patna.
Prasad, Braj Kishore, Cavendish House, Bankipore, Patna.
Prasad, Chitranjan, Minto Hinto Hostel, Room No. 33, Patna College, Patna.
Prasad, Ganesh, Medical College, Patna.
Prasad, Ganga, Medical College, Patna.
Prasad, Gopal Chandra, T. N. J. College, Bhagalpur.
Prasad, Gopiraman, Science College, Patna.
Prasad, Gupteshwar, B.Sc., Science College, Patna.
Prasad, Hardeo, B. N. College, Patna.
Prasad, Jyotir Bhusan, Medical College, Patna.
Prasad, Kashi, Science College, Patna.
Prasad, Kailash, Science College, Patna.
Prasad, Lala Dharam Bir, P. W. Medical College, Patna.
Prasad, Laliteshwar, B. N. College, Patna.
Prasad, Mahesh Bhusan, B. N. College, Patna.
Prasad, Mahesh, Bihar National College, Patna.
Prasad, Narendra Bhushan, Bihar Engineering College, Kadamkuan, Patna.
Prasad, Nityanandan, Science College, Patna.
Prasad, Paras Nath, Medical College, Darbhanga.
Prasad, Phani Bhushan, P. W. Medical College, Patna.
Prasad, Promode Ranjan, Bihar College of Engineering, Patna.
Prasad, Ram Rup, Prience of Wales Medical College, Patna.
Prasad, Rajendra, Science College, Patna.
Prasad, Rajmani, Science College, Patna.
Prasad, Ramchandra, Patna College, Patna.
Prasad, Ramraj, Patna College, Patna.
Prasad, Rajiva Ranjan, Patna College, Patna.
Prasad, Rameshwar, Science College, Patna.
Prasad, S., Bihar Engineering College, Patna.
Prasad, Shree Nandan, Science College, Patna.
Prasad, Shyam Sundar, Medical College, Patna.
Prasad, Shyamnandan, Patna College, Patna.
Prasad, Shyam Bihari, Science College, Patna.
Prasad, Vijayendra, B. N. College, Patna.
Prasad, Virendra, Science College, Patna.

Purkasta, Susanta, B. N. College, Patna.

R

Raghavan, M., C|O. Dr. P. C. Guha, Professor of Organic Chemistry, Indian Institute of Science, Bangalore.
Rai, Prabir Kumar, Science College, Patna.
Raina, M. L., Benares Hindu University, Benares.
Raja, P. Ramavarma, The Prof. of Marine Biology & Fisheries, Shankumugom, Trivandrum.
Rajagopalan, K. S., M.Sc., C|O. K. Santhanam, The Hindusthan Times, New Delhi.
Ram, R. S., Medical College, Patna.
Ramabhadran, V. K., C|O. Director, Agricultural Meteorology, Meteorological Office, Poona 5.
Ramaiah, N. Atchuta, C|O. Dr. S. S. Joshi, Science College, Benares Hindu University, Benares.
Ramamurti, M. V., C|O. Dr. S. S. Joshi, Science College, Benares Hindu University, Benares.
Ramchandran, P. V., The Prof. of Marine Biology & Fisheries, Shankumugom, Trivandrum.
Ramkumar, T. J. College, Bhagalpur.
Ramnathan, N., C|O. Spectroscopic Laboratories, Physics Dept., Royal Institute of Science, Mayo Road, Bombay 1.
Rana, Charumau, Patna Medical College, Patna.
Rao, C. Narasimha, C|O. Prof. C. Mahadevan, Head of the Dept. of Geology, Andhra University, Waltair.
Rao, D. V. Ramana, C|O. Dr. S. S. Joshi, Science College, Benares Hindu University, Benares.
Rao, G. Venkateswara, C|O. Prof. C. Mahadevan, Head of the Dept. of Geology, Andhra University, Waltair.
Rao, K, Dasaradha Rama, C|O. Director, Agricultural Meteorology, Meteorological Office, Poona 5.
Rao, (Miss) Namita, History Dept., Patna College, Patna.
Rath, Saratpriya, Philosophy Dept., Patna College, Patna.
Ray, Ramendra Nath, B. N. College, Patna.
Ray Choudhury, Kanak, Women's College, Patna.
Raza, M., Medical College, Patna.
Rohatgi, Bijyendra Prasad, B. N. College, Patna.
Rohatgi, Bhimsen, B. N. College, Patna.
Rohatgi, D., College of Mining & Metallurgy, Benares Hindu University, Benares.
Rohatgi, J. N., Medical College, Patna.
Rohatgi, (Miss) Krishna Sudha, 45, Armenian Street, Calcutta.
Rohatgi, Malti, Medical College, Patna.
Rohatgi, Prabhat Krishna, 45, Armenian Street, Calcutta.
Rohatgi, (Miss) Saroj Kumari, 45, Armenian Street, Calcutta.
Rohatgi, (Miss) Sushil Kumari, 45, Armenian Street, Calcutta.
Rohatgi, Vikramajit Singh, 45, Armenian Street, Calcutta.
Rohatgi, Virendra Mohan, B. N., College, Patna.
Roy, A. C., C|O. Dr. P. C. Guha, Prof. of Organic Chemistry, Indian Institute of Science, Bangalore.
Roy, Pranab Nath, Medical College, Patna.
Roy, Ram Naresh, Science College, Patna.
Roy, Samindra Nath, Applied Chemistry Dept., University College of Science, 92, Upper Circular Road, Calcutta 9.
Rudra, (Mrs.) L., No. 1, Shibnarayan Das Lane, Calcutta.

S

Sah, Harihar Prasad, Science College, Patna.
Sahai, Rai Chandi Nath, Medical College, Patna.
Sahai, Ramakanta, Science College, Patna.
Sahai, S. N., Bihar Engineering College, Patna.
Sahasrabudhe, R. H., C|O. Dr. S. S. Joshi, Science College, Benares Hindu University, Benares.
Sahay, (Miss) Aloknanda, Patna Wowen's College, Patna.
Sahay, Baidya Nath, Patna College, Patna.
Sahay, Dinesh Nandan Science College, Patna.
Sahay, Indradeo, Agricultural College, Sabour.
Sahay, Sachchidanand, Law College, Patna.
Sahay, Sharada Prasad, B. N. College, Patna.
Sahay, Sharada Prasad, B. N. College, Patna.
Sahay, Trailokya Nath, Patna College, Patna.
Sahay, Tarkeshwar, Science College, Patna.
Sahi, B. Pr. Narayan, Patna, College, Patna.
Sahu, Satya Deo, Govt. Degree College, Ranchi.
Sahu, S. C., Patna College, Patna.
Samaiyar, Harnandan Prasad, Science College, Patna.
Samant, Ananta Kumar, Science College, Patna.
Sanjiv, U., C|O. Mr. S. S. Ghosh, Dept. of Pure & Applied Chemistry, Indian Institute of Science, Bangalore.
Sankaran, T., 253, Broach Hostel, Hindu University P.O., Benares.
Sanyal, Alak Nath, Darbhanga Medical College, Darbhanga.
Sanyal, Nilendu, P.O., Bankipore, Patna.
Saradamma, (Miss) P., B.A., L.T., Research Scholar, Dept. of Applied Chemistry, Trivandrum.
Saran, (Miss) Indu, Patna Women's College, Patna.
Saran, Karuna Behari, Science College, Patna.
Sarif, Mohd., 83, Osmania, Muslim University, Aligarh.
Sarkar, Gangapada, Law College Hostel, Patna.
Sarkar, (Miss) Pabitra, Women's College, Patna.
Sarkar, Pabitra Kumar, Kadamkuan, Patna.
Sarma, B. Kameswara, C|O. Dr. S. S. Joshi, Benares Hindu University, Science College, Benares.
Sarma, Rajeswar Prasad, Medical College, Patna.
Saroiya, P. R., C|O. Dr. R. C. Shah, Prof. of Organic Chemistry, Royal Institute of Science, Bombay 1.
Sastri, G. Gopalakrishna, Asst. Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
Sastry, D. S., C|O. Dr. S. K. K. Jatkar, Dept. of Pure & Applied Chemistry, Indian Institute of Science, Bangalore.
Sayed Fakhar-e-Alam, Muslim University, Aligarh.
Sekhar, A. C., C|O. C. R. Sankaran, Reader in-Charge, Phonetics Laboratory, Deccan College Research Institute, Poona 1.
Sen, Achintya Kamal, Dept. of Applied Chemistry, University College of Science, 92, Upper Circular Road, Calcutta 9.
Sen, Ajitendu, Dept. of Applied Chemistry, University College of Science, 92 Upper Circular Road, Calcutta 9.
Sen, Amar Kumar, Bankura Medical School, Bankura.
Sen, Amiya Kumar, 37|5, Russa Road, Calcutta 26.
Sen, Arijit, Science College, Patna.
Sen (Miss) Aruna Sen, C|O. Dr. A. K. Sen, B. M. Das Road, P.O., Bankipore, Patna.

Sen, Apurba, C|O. Dr. A. K. Sen, Patna.
Sen, J., Dept. of Botany, University College of Science, 35, Ballygunge Circular Road, Calcutta.
Sen, (Miss) Kana, C|O. Dr. A. K. Sen, B. M. Das Road, P.O., Bankipore, Patna.
Sen, S., 92, Upper Circular Road, Calcutta.
Sen Gupta, Dipak Kumar, Science College, Patna.
Sen Gupta, (Miss) Namita, University College of Science,
Sen Gupta, Supravat, B. N. College, Patna.
Sen Gupta, (Miss) Supriya, Patna College, Patna.
Sen Gupta, Sumantra, Science College, Patna.
Seth, (Miss) M., Medical College, Patna.
Sharan, K., Medical College, Patna.
Sharan, R. K., 288, Broach Hostel, Hindu University, P.O., Benares.
Sharan, T. K., Bihar Engineering College, Patna.
Shareef, S. M., Bihar Engineering College, Patna.
Sharma, Akhileswar, Medical College, Patna.
Sharma, Akshay Lall, Mussalahpur, Patna.
Sharma, Basant Lal, C|O. Prof. N. L. Sharma, Dhanbad.
Sharma, Kalidas Prasad, Science College, Patna.
Sharma, Kailash Bihari, Science College, Patna.
Sharma, Rama Shankar, B. N. College, Patna.
Sharma, Vijay Kumar, 3, Engineers College, Patna.
Sharma, Shree Shankar, Science College, Patna.
Shaw, Susil Kumar, B. N. College, Patna.
Sheshayya, V., Muslim University, Aligarh.
Shrivastava, Chandra Nath, Science College, Patna.
Shrivastava, Sita Sharan, Patna College, Patna.
Shukla, B. M., C|O Dr. S. S. Joshi, College of Science, Benares Hindu University, Benares.
Siddhanta, N. N. S., C|O Dr. S. S. Joshi, College of Science, Benares Hindu University, Benares.
Singh, A. K., Patna College, Patna.
Singh, Aniruph, Jackson Hostel, Patna College, Patna.
Singh, Awadh Keshore Narain, Medical College, Darbhanga.
Singh, Baleshwar, Patna College, Patna.
Singh, Bhola Nath, Rajendra College, Chapra.
Singh, Biswa Nath, Medical College, Patna.
Singh, Biswa Nath, Patna College, Patna.
Singh, Bidya Sagar, St. Columba's College, Hazaribagh.
Singh, Bhrigu Nath, Science College, Patna.
Singh, Chandeswar Prasad, Darvanga Medical College, Patna.
Singh, C. P. Narain, Patna College, Patna.
Singh, Damri, C|O Dr. S. S. Joshi, College of Science, Benares Hindu University, Benares.
Singh, Harendra P., Medical College, Patna.
Singh, Jagdish Chandra, Science College, Patna.
Singh, Janardan Pd., Patna College, Patna.
Singh, J. N., Medical College, Patna.
Singh, Kamaleswar, 17, Medical College Hostel, Bankipore, Patna.
Singh, Kedar Nath, Jackson Hostel, Patna.
Singh, Kedar Prasad, Science College, Patna.
Singh, Lakshmi Narayan,, B. N. College, Patna.
Singh, Lal Saheb, Science College, Patna.
Singh, Manindra Prasad, Kadam Kuan, Patna.

Singha, Narendra Nath, Science College Hostel, Patna.
Singh, Naresh, B. N. College, Patna.
Singh, Premananda, Science College, Patna.
Singh, Ram Badan, Science College, Patna.
Singh, Ramnath, C|O Dr. S. S. Banerjee, Engineering College, Hindu University, Benares.
Singh, Ram Subhag, Science College, Patna.
Singh, Ram Janma, Science College, Patna.
Singh, Rangi Prosad, P. W. Medical College Patna.
Singh, Ram Chandra, Science College, Patna.
Singh, Ram Naresh, B. N. College, Patna.
Singh, Rajendra Kumar, Science College, Patna.
Singh, Sarda Prasad, P. W. Medical College, Patna.
Singha, Saksmi Narayan, Patna College, Patna.
Singh, Shalagram, Patna College, Patna.
Singh, Shesh Narayan, Science College, Patna.
Singh, Shiv N., Medical College, Patna.
Singh, Sitaram Prasad, Patna College, Patna.
Singh, Tarakeshwar, Patna College, Patna.
Singh, Trebhuban Prasad, Patna College, Patna.
Singh, Tarkeshwar Prasad, B. N. College, Patna.
Singh, Trilochan, Saugar University, Saugar.
Singh, (Miss) Usa, Medical College, Patna.
Siddiqui, Ghulam Mahamad, Muslim University, Aligarh.
Sinha, A. K., Engineering College, Patna.
Sinha, Arjun, Science College, Patna.
Sinha, A. N., Medical College, Patna.
Sinha, Amal Kumar, B. N. College, Patna.
Sen, Apurba, C|O Dr. A. K. Sen, Patna.
Sinha, B. K., Engineering College, Patna.
Sinha, Bijay Kumar, B. N. College, Patna.
Sinha, B. P., Medical College, Patna.
Sinha, Brahma Deva Narayan, P. W. Medical College, Patna.
Sinha, Chandreshwar Prasad, Science College, Patna.
Sinha, Devendra Prasad, Science College, Patna.
Sinha, Hari Shankar, Science College, Patna.
Sinha, Harihar, Science College, Patna.
Sinha, Haribansh Narayan, Medical College Hostel, Bankipore, Patna.
Sinha, Jagdish, Patna College, Patna.
Sinha, Jagadish Prasad, Science College, Patna.
Sinha, Jagadish Prasad, Science College, Patna.
Sinha, Janardan Prasad, Science College, Patna.
Sinha, Jawahar, Science College, Patna.
Sinha, Kanti Kumar, B. N. College, Patna.
Sinha, Kedar Nath, Patna College, Patna.
Sinha, (Miss) Madhuri, Patna Women's College, Patna.
Sinha, Maheshwar Parasad, Science College, Patna.
Sinha, Nawal Kishore Prasad, Science College, Patna.
Sinha, Rajendra Mohan, Medical College, Patna.
Sinha, Rajendra Kishore, Science College, Patna.
Sinha, Rajendra Prasad, Science College, Patna.
Sinha, R. P. Medical College, Patna.
Sinha, Ranjit Kumar, Science College, Patna.
Sinha, Ranjit, Bihar Engineering College, Patna.

Sinha, R. R. P., Science College, Patna.
Sinha, Sachidanand, Science College, Patna.
Sinha, (Miss) Sashilata, Patna College, Patna.
Sinha, Sheoshankar Prasad, Patna College, Patna.
Sinha, Shymal, B. N. College, Patna.
Sinha, (Miss) S., Medical College, Patna.
Sinha, Siddheshwari Narayan, Darbhanga Medical College, Darbhanga.
Sinha, Sri Krishna, Dept. of Psychology, Patna University, Patna.
Sinha, Shreeman, Science College, Patna.
Sinha, (Miss) Sita, Medical College, Patna.
Sinha, Tara Kumar, Patna College, Patna..
Sinha, Uday, Patna College, Patna.
Sivaraman, P. S., C|O C. R. Sankaran, Reader in-Charge, Phonetics Laboratory, Deccan College Research Institute, Poona 1.
Subramaniyam, K., Dept. of Botany, Central College, Bangalore.
Subramaniam, P. S., Benares Hindu University, Benares.
Sudhi, Ramesh Chandra, P. W. Medical College, Patna.
Sudhi, Birendra Mohan, P. W. Medical College, Patna.
Sujir, R. J., C|O. Dr. S. K. K. Jatkar, Dept. of Pure & Applied Chemistry, Indian Institute of Science, Bangalore.
Sur, Sudhansu Kumar, Applied Chemistry Dept. University College of Science, 92, Upper Circular Road, Calcutta 9.

T

Tewari, R. N., Medical College, Patna.
Tiwari, Kapil Deo, Student, P. W. Medical College, Patna.
Tiwari, S. N., C|O Dr. S. S. Joshi, College of Science, Benares Hindu University, Benares.
Trigunait, Pasnpati, Science College, Patna.
Tripathi, (Miss) A., Medical College, Patna.
Tripathi, Kamala Kanta, Patna College, Patna.
Tripathi, S. N., Allahabad University, Allahabad.

U

Upadhya, (Miss) Sharda, Science College, Patna.

V

Varma, Alakh Niranjan, Science College, Patna.
Varma, (Mrs.) Jamuna, Patna Women's College, Patna.
Varma, P. N., Medical College, Patna.
Varma, Shiv Kumar, Science College, Patna.
Venkaiah, E., C|O Prof. C. Mahadevan, Head of the Dept. of Geology, Andhra University, Waltair.
Venkatadas, R., General Chemistry Section, Indian Institute of Science, Bangalore.
Venkateswaran, S. S., Agricultural Meteorological Section, Meteorological Office, Poona.
Verma, Krishna Murari, B. N. College, Patna.
Verma, Priya Ranjan, Bihar Engineering College, Patna.
Verma, Raghu Jee, Geology Dept. Patna University, Patna.

Verma, Satya Deva Narayan, Science College, Patna.

Verma, Upendra Prasad, Science College, Patna.

Vidyarathi, B. P., Science College, Patna.

W

Wadera, S. P., Patna College, Patna.

Warke, K. P., C|O Dr. S. K. K. Jatkar, Indian Institute of Science, Bangalore.

Y

Yadava, (Mrs.) Rama B. P., C|O Dr. B. P. Yadava, Chemistry Dept. The University, Lucknow.

INDEX

B

C

D

F

G

H

I

J

L

M

N

O

P

Q

R

S

T

U

V

W

X

Z